LESSONS

IN

PHYSICAL DIAGNOSIS.

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PREFACE.

In compliance with the request of my classes in physical diagnosis, these lessons were first published.

The call for a third edition has led me to feel that they have supplied, at least to some extent, a want felt by students in physical diagnosis.

In issuing the present edition, I have endeavored to make it a more complete guide in diagnosis, by revising and enlarging the original text, and by adding five new lessons,—three on examination of the urine as applied to diagnosis, and two on the mechanical aids to diagnosis.

In my rules for urinary examinations, I have confined myself to the ordinary requirements of the student or practitioner; the expert has little need for the simple rules given. The test solutions for volumetric analysis and the details for their employment, together with the necessary apparatus, have been arranged for me by my friend Dr. H. G. Piffard, of this city.

In the lessons on the mechanical aids to diagnosis, I have

briefly described and given as concisely as possible, rules for the use of those instruments which the medical practitioner will find of service in the diagnosis of disease. No one can be an expert in the use of all of these, yet every student and practitioner can easily make himself so familiar with their use, as to advantageously employ them in those cases where the symptoms and ordinary modes of investigation fail.

I am indebted to my assistant, Dr. F. R. S. Drake, for the drawings of the new wood-cuts which illustrate the text.

42 WEST TWENTY-FIFTH STREET,
August, 1872.

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LUNGS.

LESSON I.

*Introduction.—Topography of the Walls of the Chest.—
Contents of the Various Regions.*

GENTLEMEN.

Physical Diagnosis is a term used to designate those methods which are employed for detecting disease during life, by the anatomical changes which it has produced. The nature and extent of such changes can be recognized and appreciated by the deviations which they cause in the affected organs from the known physical condition of these organs when in health. The significance of physical signs in disease can be determined, not by theory, but only through clinical observation confirmed by examinations after death.

There are six methods of eliciting these physical signs, termed "physical methods of diagnosis;" viz., *Inspection, Palpation, Mensuration, Succussion, Percussion,* and *Auscultation.*

The most important of these are *Auscultation* and *Percussion.* The other methods are only subsidiary to these two, and can seldom be regarded as furnishing positive evidence of disease. For a complete and accurate physical exploration, you must sometimes employ all these different methods, and with all, therefore, you should become familiar.

In order to localize physical signs, the chest has been divided into artificial regions, but as the limits of these regions are arbitrary, the boundaries adopted by different writers vary. The following divisions, which correspond very nearly to those proposed by many authorities, you will find, I think, sufficiently small and well-defined for practical pur-

poses. It is important that you should be familiar, not only with the boundaries of these regions, but with the relative position of the structures and organs or portions of organs included within them.

The surface of the chest may be divided into three general regions,—*Anterior*, *Posterior*, and *Lateral*. The *Anterior region*, on either side, may be subdivided into *Supra-Clavicular*, *Clavicular*, *Infra-Clavicular*, *Mammary*, and *Infra-Mammary*. Between these two regions we have the *Supra-Sternal*, *Superior Sternal*, and the *Inferior Sternal*. The *Posterior region*, on either side, may be subdivided into the *Superior Scapular*, *Scapular*, and (*Infra*) *Scapular*. Between these you have the *Inter-Scapular*. The *Lateral region*, on either side, may be subdivided into *Axillary*, and *Infra-Axillary regions*.

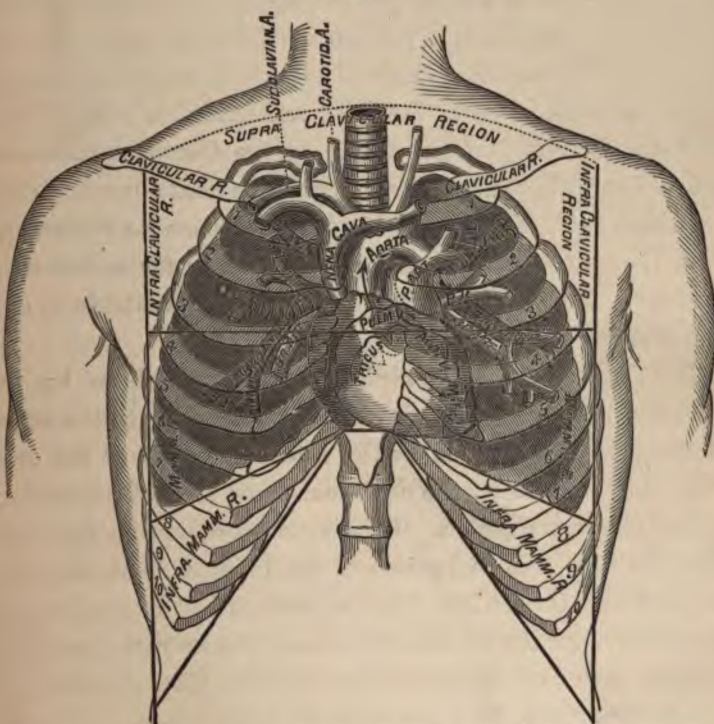
The **Supra-Clavicular** region is a triangle whose base corresponds to the trachea, lower side to the clavicle, upper side to a line drawn from the outer third of the clavicle to the upper rings of the trachea. This region contains, on either side, the apex of the lung, with portions of the subclavian and carotid arteries, and the subclavian and jugular veins.

The **Clavicular** space is that which lies behind the inner three-fifths of the clavicle, and has the bone for its boundary. It is occupied on both sides by lung tissue; on the right side, at its outer extremity, lies the subclavian artery: at the sterno-clavicular articulation, the arteria innominata. On the left side, almost at right angles with the bone, and deeply seated, are the carotid and subclavian arteries.

The **Infra-Clavicular** region has for its boundaries, the clavicle above, the lower border of the third rib below, the edge of the sternum inside, and outside a line falling vertically from the junction of the middle and outer third of the clavicle. Within these limits, on both sides, you will find the superior lobe of the lung and the main bronchi; the right bronchus lies behind, and the left a little below the second

costal cartilage. On the right side, close to the sternal border of the region, lie the superior cava and a portion of the arch of the aorta; on the left, a portion of the pulmonary artery. The aorta and pulmonary artery are immediately behind the second sterno-costal articulation; the one on the right, the

Fig. 1.



The Anterior Region, the Boundaries of its Subdivisions, and the Organs Corresponding to these Subdivisions.

other on the left side of the sternum. On the left side the lower boundary of the region very nearly corresponds to the base of the heart.

The **Mammary** region is bounded above by the third rib; below by the inferior margin of the sixth rib; inside by the edge of the sternum; and outside by a vertical line, continu-

ous with the outer border of the infra-clavicular region. You will find this region to differ materially in its contents on the two sides. On the right side the lung is found extending in front, down to the sixth rib, where its thin, sharp border very nearly corresponds to the lower boundary of the region. The right wing of the diaphragm, though not attached higher than the seventh rib, is usually pushed up by the liver as high as the fourth interspace; a portion of the right auricle of the heart, and the superior angle of the right ventricle, lie close to the sternum, between the third and fifth ribs. On the left side, the lung is in front as far as the fourth sterno-costal articulation, where its anterior border passes outwards, until it reaches the fifth rib (leaving an open space for the heart); then it crosses forwards and downwards as far as the sixth rib; a small portion of the apex of the right ventricle is also found within this region.

The **Infra-Mammary** region is bounded above by the sixth rib; below by a curved line corresponding to the edges of the false ribs; inside by the inferior portion of the sternum; and outside by the continuation of the outer boundary of the mammary region. This region contains, on the right side, the liver, with a portion of the lung in front, on a full inspiration. On the left, lying in front, near the median line, you have a portion of the left lobe of the liver, the stomach, and the anterior border of the spleen. The stomach and spleen usually rise to a level with the sixth rib.

The **Supra-Sternal** region is the space which lies immediately above the notch of the sternum, and is bounded on either side by the sterno-mastoid muscle. It is occupied chiefly by the trachea, by the arteria innominata at its lower right angle, and by the arch of the aorta, which sometimes reaches to its lower border, where, on firm downward pressure with the end of the finger, you will often be able to feel it.

The **Upper Sternal** region is the space bounded by that

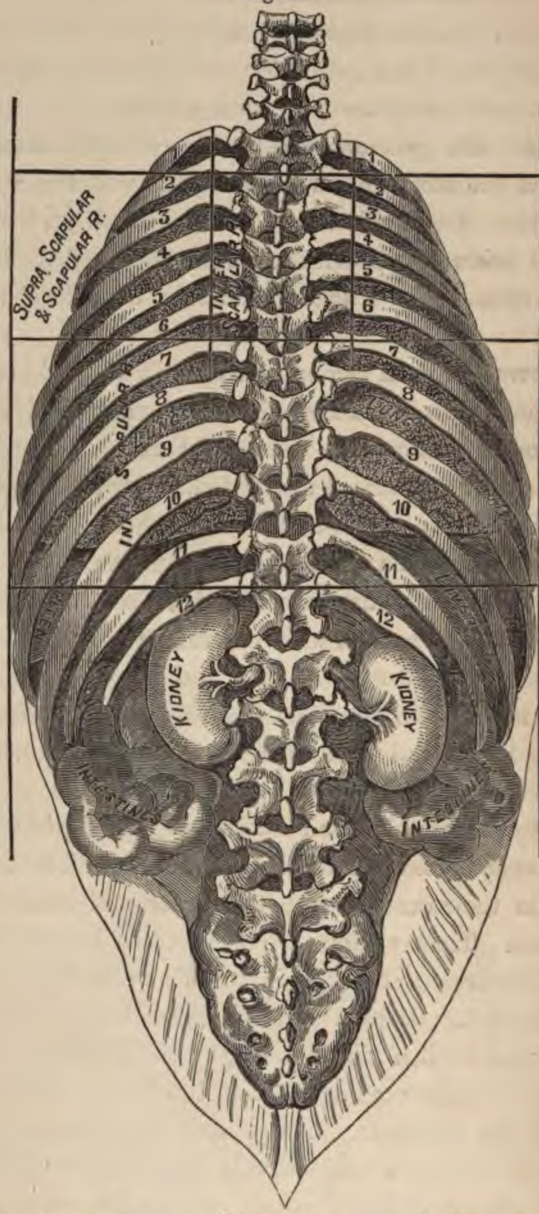
portion of the sternum which lies above the lower margin of the third rib. In this region the lung lies in front; immediately behind it are the ascending and transverse portions of the aorta, and the pulmonary artery from its origin to its bifurcation. The pulmonary valves are situated close to the left edge of the sternum, on a level with the lower margin of the third rib. The aortic valves are about half an inch lower down, and midway between the median line and the left edge of the sternum. The trachea bifurcates on a level with the second ribs.

The **Lower Sternal** region corresponds to that portion of the sternum which lies below the lower margin of the third rib. Throughout the whole extent of this region on the right side, the lung is in front; it also extends down on the left side as far as the fourth sterno-costal articulation; below this lies the greater part of the right ventricle, and a small portion of the left. The mitral valves are situated close to the left edge of the sternum, on a level with the fourth rib; the tricuspid valves are nearer the median line, and are more superficial; inferiorly is the attachment of the heart to the diaphragm; below this is a small portion of the liver, and sometimes of the stomach.

The **Supra-Scapular** and **Scapular** regions together occupy the space from the second to the seventh rib, and are identical in their outlines with the upper and lower fossæ of the scapula. These regions are occupied by lung substance.

The **Infra-Scapular** region is bounded above by the inferior angle of the scapula and the seventh dorsal vertebra; below, by the twelfth rib; outside, by the posterior border of the lower axillary region; and inside by the spinous processes of the vertebræ. Immediately underneath the surface, as far as the eleventh rib, this region is occupied by the lungs. On the right side the liver extends downwards beyond the level of the eleventh rib; on the left, the intestine occu-

Fig. 2.



The Posterior Region, the Boundaries of its Subdivisions, and the Organs Corresponding to these Subdivisions.—After SIBSON.

pies the inner part of this region, and the spleen the outer. Close to the spine, on each side,—more on the left than on the right,—a small portion of the kidney is found; along the left side of the spine runs the descending aorta.

The **Inter-Scapular** region is the space between the inner margin of the scapula and the spines of the dorsal vertebræ, from the second to the sixth. This region contains, on both sides, lung substance, the main bronchi, and the bronchial glands. It also encloses on the left side the œsophagus, and from the upper part of the fourth dorsal vertebra downwards, the descending aorta. The bifurcation of the trachea will be found opposite the third dorsal vertebra.

The **Axillary** region has for its limits, the axilla, above; below, a line carried backwards from the lower boundary of the mammary region to the inferior angle of the scapula; in front, the outer margin of the infra-clavicular and mammary regions; and behind, the external edge of the scapula. This region corresponds to the upper lobes of the lungs, with the main bronchi deeply seated.

The **Infra-Axillary** region is bounded above by the axillary region; anteriorly, by the infra-mammary; posteriorly, by the infra-scapular; and below by the edges of the false ribs. This region contains, on both sides, the lower edge of the lung sloping downwards and backwards. On the right side is the liver, and on the left the stomach and spleen.

LESSON II.

Inspection, Palpation, Mensuration, and Succussion.

Inspection is the ocular examination of the external surface. Though usually secondary in importance to Auscultation and Percussion, it should not be lightly regarded, for it often furnishes you much information respecting the condition of the thoracic and abdominal viscera. By Inspection you recognize changes in the size, form, or symmetry of these cavities, and in the movements of their walls during respiration, as regards their rhythm, frequency, or force.

As students of anatomy you are familiar with the form of a well-proportioned chest; a description of it is therefore unnecessary; suffice it to say, that in a normal state the two sides are symmetrical in every part: the intercostal spaces are more or less distinct, according as the individual is more or less fat. In quiet respiration, you will notice the abdomen rise with inspiration, and fall with expiration; at the same time you will observe a lateral expansion of the lower ribs, and a slight upward movement of the upper part of the chest with inspiration, and a downward movement with expiration. The movements of respiration in these three situations are called, respectively, *abdominal, inferior costal,* and *superior costal breathing.* In the female, the superior costal breathing is most marked. In the male, the inferior and abdominal.

Considerable alterations in the form and movements of the chest are compatible with a healthy condition of the thoracic

viscera. You rarely meet with a perfectly symmetrical chest, even among the healthy. In my examination of 1,500 persons, I found only one well-proportioned, symmetrical chest in seven. As you can easily recognize these healthy deviations from symmetry, I shall not enter into details concerning them. I would however mention that slight curvatures of the spine, either acquired or the result of former disease of the vertebræ, cause the majority of these deviations.

We will first consider only those changes in the size, form, and movements of the thoracic cavity which are the result of disease of the thoracic organs; confining ourselves at present to the lungs and pleuræ. The readiest way of presenting these changes to you, it seems to me, is to consider them as they occur in the different thoracic affections. First, we will consider the signs obtained by inspection in pleurisy; in the first stage, prior to the occurrence of much liquid effusion, there is no apparent change in the size, but the movements of the affected side are diminished, and those of the healthy are increased; you have what is termed a catching respiration. This sign is not distinctive of pleurisy: it is present in intercostal neuralgia, and in pleurodynia. In the stage of fluid effusion, if the liquid is sufficient to compress the lung and dilate the thoracic walls, the affected side will be increased in size, and in proportion to the dilatation its movements are restricted or arrested. If the cavity is completely filled with fluid, there will be bulging and widening of the intercostal spaces, with more or less displacement of the adjacent viscera. As the fluid is absorbed the lung expands, but not to the same volume it had before. It remains more or less contracted, and the consequence is, retraction of the affected side from atmospheric pressure. Generally, if the fluid effusion shall have existed a length of time previous to absorption, the subsequent retraction is marked, and you can determine at once by inspection, that pleurisy has existed at some period more or less remote.

In Pulmonary Emphysema, if it is a well-marked case, on inspection you will notice a dilatation of the upper portion of the chest, while its whole aspect appears more rounded than in health, so that it has received the name "barrel-shaped" chest; the shoulders are elevated and brought forward, the movements in respiration are limited to the lower portions of the chest and to the abdomen. On inspiration, there is no outward expansive movement of the ribs; the sternum and ribs seem to move up and down as if they were composed of one solid piece; in some cases of long standing you will have actual falling in instead of expansion of lower ribs during inspiration. In a well-marked case of emphysema, *inspection* is quite sufficient for a diagnosis, but where the lungs are but slightly emphysematous, inspection furnishes no positive information. In pneumonia, the only sign furnished by inspection is that the movements of the affected side are restrained as in the first stage of pleurisy. In phthisis pulmonalis, inspection furnishes you important information. Depression in the infra-clavicular region on the affected side is an early sign of tubercular deposit. In advanced phthisis the depression is still more marked, in some instances amounting almost to deformity. The expansive movements in inspiration on the affected side in the infra-clavicular region are diminished or entirely wanting, and this want of expansion is often noticeable at a very early period in the disease.

Bulging or partial enlargement of the chest, determinable by inspection, occurs in various affections. Enlargement of the præcordia is observed in certain cases of hypertrophy or dilatation of the heart, or from fluid effusion in the pericardium. Bulging occurs also over aneurismal and other tumors.

In cases of membranous croup, acute and chronic laryngitis, and œdema glottidis, inspection will disclose to you the seat of the obstruction to the passage of air to the lung by a sinking in during inspiration of the parts of the chest which yield

most readily to atmospheric pressure. This sinking in on inspiration you will notice, first in the supra-clavicular spaces, then in the infra-clavicular spaces, and as the obstruction increases, the sternum is depressed and the sides contracted.

Although furnishing few positive evidences of disease, you should always employ inspection prior to the other methods of physical exploration. This is important in all cases where the evidences furnished by the other physical signs are not conclusive.

Palpation, or the act of laying on the hand and feeling the external surface of the body, is less useful than inspection in ascertaining deformities, and the amount of general movement; but it is more useful in determining the amount of local expansion, and the character of vibration or impulses communicated to the external surface.

In order to arrive at satisfactory results from its employment, you should observe the precautions already named as influencing accurate inspection; beyond this, I need only mention that in thoracic examinations the hand or the fingers should be gently and evenly applied to the surface of the chest, and that corresponding portions of the two sides of the thorax should be examined simultaneously, the one with the right hand, and the other with the left. If you lay your hand lightly upon the surface of the chest of a healthy person while speaking, a delicate tremulous vibration will be felt, varying in intensity with the loudness and coarseness of the voice and the lowness of its pitch; this is called *normal vocal fremitus*. As a rule, vocal fremitus is more marked in adults than in children, in males than in females, and in thin than in fat persons. In the right infra-clavicular region it is more marked than in the left. Variations in the vocal fremitus are the most important evidences of disease furnished by palpation; in fact all other evidences of pulmonary disease afforded by palpation are better obtained by inspection.

In disease the normal vocal fremitus may be *increased*, *diminished*, or *entirely absent*.

Increased vocal fremitus occurs in those affections in which lung tissue becomes more or less solidified, as in tuberculosis, pneumonia, pulmonary apoplexy, and œdema of the lung. When the consolidation is extreme, involving bronchial tubes of considerable size, the vocal fremitus may be diminished or even absent; while increase in the size of the bronchial tubes, with the slight adjacent consolidation met with in chronic bronchitis, often gives rise to increased vocal fremitus.

Diminution or absence of the normal vocal fremitus occurs whenever the lung substance is separated from the chest walls by gaseous or liquid accumulations in the pleural cavity, as in pneumo-thorax, serous, plastic, hæmorrhagic, or purulent pleuritic effusions. In vesicular emphysema, owing to the dilated condition of the air cells, vocal fremitus is diminished. Besides these valuable indications furnished by vocal fremitus, you may employ palpation to detect the friction caused in pleurisy by the rubbing together of the two roughened surfaces of the pleural membrane, and which is termed *friction fremitus*.

Sibilant and sonorous rales also sometimes throw the bronchial tubes into vibration, sufficiently strong to be felt on the surface of the chest; this is termed *sonorous* or *rhonchial fremitus*. Cavernous gurgles produced in excavations near the surface may be accompanied with a marked fremitus.

Mensuration is another method of physical exploration, employed for obtaining information similar to that furnished by inspection and palpation. We seldom employ it in physical examinations of the lungs unless great accuracy is required, as in the record of cases. The instruments which have been devised for the measurement of the chest and the different lines of measurement are numerous. The circular measurement is the only one that I have found of practical value in investigating pulmonary disease. The simplest and most

accurate mode of measuring the circular dimensions of the chest is by means of the instrument devised by Dr. Hare, which consists of two pieces of tape similarly graduated, joined together, and padded on their inner surface close to the line of junction; the saddle thus formed when placed over the spine readily adjusts itself to the spinous processes, and becomes fixed sufficiently for the purpose of mensuration. For comparing the expansive movements of the two sides you will find Dr. Quain's stethometer[1] very useful. The object of the circular measurement of the chest is twofold—first, to ascertain the comparative bulk of the two sides; second, to ascertain the amount of expansion and retraction accompanying inspiration and expiration of the two sides. The points of measurement are the spinous processes behind and the median line in front, on the level of the sixth costo-sternal articulation.

The average circular dimension of the chest at this point in 1,500 healthy persons was thirty-two and a half inches. I also found in these examinations that about four-fifths of healthy adults have irregularity of the two sides. In right-handed individuals the right side is about one-half inch larger than the left; in left-handed, the left. This is true of both sexes.

The really important point of mensuration in pulmonary diseases, is the comparison of the two sides of the chest, in rest and in motion. When a pleural cavity is distended with air or fluid, the measurement of the affected side may exceed that of the healthy side, by two or three inches; after the removal of the fluid, there may be an equal diminution in the measurement of the affected side, as compared with the healthy one.

Deficiency of expansion is also very marked in certain diseases. In empyema, for instance, you will often find the total difference between the fullest inspiration and the fullest expiration on the affected side will scarcely exceed one sixteenth of

[1] *Vide* Lesson XVI.

an inch, while on the other side, there may be a difference of two or three inches.

The list of affections in which variations in expansion are to be estimated by measure are the same as those referred to under the head of Inspection.

The measurement of the capacity of the lungs for air, by means of Dr. Hutchinson's spirometer, or of the "vital capacity of the chest," as he terms it, has been shown by experience to be very unreliable, and his instrument has fallen almost entirely into disuse.

Succussion, as a method of physical diagnosis, is almost exclusively applicable to the diagnosis of a single disease; viz., pneumo-hydrothorax. It is performed by suddenly shaking the trunk of the patient, while your ear is applied to the surface of the chest; the sound produced resembles that perceived on shaking a bottle partly filled with water close to the ear; it is a gurgling, splashing noise, and varies in tone with the density of the fluid, and the relative quantities of fluid and air present. It is almost always accompanied by amphoric respiration and metallic tinkling. I shall reserve its further consideration until I detail the physical signs of pneumo-hydrothorax.

LESSON III.

Percussion.

Percussion, as a means of diagnosis, is not of recent date, for we find it mentioned by Hippocrates. But as the only mode of practising it was by striking the surface itself with the tips of the fingers, or knuckles, now termed technically, *immediate* percussion, its uses were very limited. Within our time, however, M. Piorry gave it an entirely new value by introducing *mediate* percussion ; the stroke being made, not on the surface, but on some intervening substance applied to it ; and he so demonstrated, by experiments on living and dead bodies, its superior applicability for determining changes in the subjacent parts, that mediate percussion ranks now only second to auscultation among the methods of physical exploration.

To estimate the value of percussion and to understand its true significance, you must first learn to appreciate correctly the elements of sound. Authors have employed a variety of terms to designate them, such as clearness, dulness, emptiness, fulness, etc. ; but I think, that a classification based upon analysis of the elements of sound in general, will afford us the truest and most practical distinctions, especially in estimating the sounds in thoracic percussion. Those elements or acoustic properties of percussion sounds which concern us clinically are termed, respectively, *Intensity*, *Pitch*, *Quality*, and *Duration*, of which Pitch ranks first in importance.

The **Intensity** of a percussion sound may be increased or diminished, by increasing or diminishing the force of the per-

cussion blow. But in *pulmonary* percussion, you will find that the intensity depends not only on the force of the blow, but is further modified by the amount of air contained in the lung tissue, by the thickness of the soft parts covering the thoracic walls, and also by the elasticity of the costal cartilages.

The **Pitch** of the percussion sound is always low over healthy lung substance, and, as a rule, the greater the quantity of air contained in the corresponding pulmonary tissue, the lower the pitch: consequently, you will find the pitch of the percussion sound varying very perceptibly in the different regions of a healthy chest. You can however familiarize the ear with the characters of normal pitch, only by constant practice.

Quality in sound is that element by which we distinguish any given sound from every other. Thus it is by the quality that you know the sound of one musical instrument from another. The quality of the note emitted on percussion over healthy lung substance, and termed normal vesicular resonance, is sufficiently marked and peculiar to be easily recognized, though it cannot be easily described, and is to be learned only by experience.

The **Duration** of a given sound you will find varying according to the pitch of that sound; the higher the pitch, the shorter the duration, and *vice versâ*. For example, the duration of the percussion sound is perceptibly longer in the infra-clavicular region of a healthy chest than over the heart.

You will find that a certain definable relationship exists between these respective elements of the percussion note, which has a correspondence to the different regions of the chest. Thus after noting the intensity, pitch, quality, and duration of the percussion sound in the infra-clavicular region, you will find that over the heart it has a higher pitch and harder quality, but a less intensity and a shorter duration.

The substance which receives the stroke in mediate percussion is termed a *plessimeter*, of which many varieties have

been devised, made of wood, ivory, gutta percha, etc. They are in nowise superior, however, to the left index or middle fingers, when their palmar surface is applied evenly to the chest, for these, besides being of course the most *handy*, also answer best the chief requisite of a plessimeter in that they can be easily fitted with accuracy to any part of the thoracic walls. Moreover, their own proper sound, on being struck, is inappreciable, which is not the case with ivory, wood, etc. Likewise, you will discover nothing better to strike *with* than the finger tips of the other hand, brought into line; while for gentle percussion, the middle finger alone may suffice.

Now, as the practice of percussion requires some manual dexterity, and the correctness of its indications depends in great measure upon the mode in which it is performed, you will find it useful to have recourse to the following rules as your guides:

First. You should attend as carefully to the position of your patient as a photographer would if he were going to take his likeness. Whether lying, sitting, or standing, his body should rest on the same plane, and his limbs be disposed similarly, on either side, so as to render the muscular tissue covering the thoracic walls equally tense. In percussing particular regions, however, the first aim is to make the intervening tissue, as firm and thin as possible. Thus when you percuss the front of his chest, the arms should hang loosely down, but the head be thrown back. On the contrary, the arms should be raised to the level of the head when you are percussing the lateral regions, and should be crossed in front, the patient leaning moderately forwards when you percuss the back. It is better to percuss on the naked skin; but various considerations may make this unadvisable, you should then aim to have the covering as soft, thin, and especially as even as possible.

Second. The two sides of the chest should, for comparison

be percussed at the same stages of the respiratory act. You should also take care to compare only corresponding portions in the two sides. Thus you should not compare a note during inspiration on the right side with one during expiration on the left, nor that over a rib with that of an interspace.

Third. The finger or plessimeter should be applied with equal firmness, and in the same parallel to both sides in succession, and the force of the percussion should be exactly the same; for the sound will vary considerably even on the same spot, whether you press lightly or firmly with your finger, whether it is across a rib or along it, and finally, whether you strike gently or forcibly.

Fourth. The stroke in percussion should be made from the wrist alone, the arm and forearm not participating in it; and its force should be proportioned to the depth of the part to be examined,—gentle if superficial, and forcible when deep seated.

Percussion in Health.—The significance of the percussion sounds in disease depends so entirely on their variation from the sounds which are proper to the part in health, that you cannot pay too much attention to the various characters of *normal* thoracic percussion; for on this, almost every deduction which results from your examination is based. Now the percussion sounds differ materially in a healthy thorax according to the region percussed. Taking the percussion note of the infra-clavicular region as the standard for pulmonary percussion, we find each of the other regions has its own variations from it. In the *right infra-mammary* region you will get, by gentle percussion, the same note as in the infra-clavicular; but forcible percussion, at and below the fourth interspace, will raise the pitch and harden the quality, owing to the presence of the liver behind the shelving border of the lung. Over the left *infra-mammary* region, the pitch is similarly varied from the presence of the heart, until it reaches complete flatness at its inner border. The resonance of the *right infra-mammary*

region has a harder quality, higher pitch, and shorter duration, from the presence of the liver immediately beneath. The *left infra-mammary* region is similarly affected at its inner part by the left lobe of the liver, and at its outer border by the spleen, while the intermediate space gives a tympanitic resonance from the subjacent stomach. Over both *clavicles* you will get a mixed pulmonary and osseous resonance, while in the *supra-sternal* region, the percussion sound has a distinctly tubular character. In the *superior sternal* region, it has a bony tubular resonance down to the second rib; below this, to the third rib, it is raised in pitch and hardened in quality. The dulness on percussion becomes complete in the next region, or *inferior sternal*, owing to the presence of the heart and great vessels, together with the left lobe of the liver.

The **Superior** and **Middle Axillary** regions are extremely resonant as far down as the fourth interspace; the pitch is even lower than in the infra-clavicular region, but below the fourth interspace, the pitch rises, till complete dulness is found on a level with, and below the seventh rib. This dulness continues through the *infra-axillary* regions on either side.

In the **Superior Scapular** and **Scapular** regions the percussion sound is high-pitched and hard in quality, except in the supra-spinous fossæ, where it has the soft quality, characteristic of pulmonary percussion. In the *infra-scapular* region you have pulmonary resonance as far down as the tenth rib, and complete flatness below. In the *inter-scapular* region, the percussion is high-pitched and tubular in quality.

Besides variations in percussion sounds dependent on difference in regions, there are still others ascribable to age, sex, idiosyncrasies, etc. You will find the percussion sound in children of a softer quality and lower pitch than in adults: while in the aged it rises in pitch, and measurably loses its pulmonary quality. In females, the percussion sound is rela-

tively more pulmonary in all its characters than in males. Marked deformity of the chest, whether congenital or acquired, also modifies the normal resonance. But it also varies materially in different individuals who are equally healthy. In some persons this difference may be accounted for, while in others it cannot; but as a rule the thinner the chest walls, the greater is the intensity, the lower the pitch, and the more pulmonary the quality of the percussion sound.

Percussion in Disease.—It is obvious, from what precedes, that whatever modifies the density of the lung substance, and changes its proper elasticity, will cause a corresponding modification in the normal pulmonary resonance; for as the lung texture is rendered more dense, or less so, than natural, the percussion sound passes through every gradation from marked resonance to complete dulness. These modifications, caused by disease, we would classify under the following heads; viz., *Exaggerated Pulmonary Resonance, Dulness, Flatness, Tympanitic Resonance, Vesiculo-Tympanitic Resonance, Amphoric Resonance,* and *Cracked-Pot Resonance.*

Exaggerated Pulmonary Resonance consists in an increase of the intensity of the sound; the pitch being slightly lower, while the quality remains unchanged. This sign may exist to a slight degree over the whole, or over a portion of a lung which is performing more than its usual share of labor. Thus if one pleural cavity is filled with fluid, or if one lung is solidified by the exudation of pneumonia, or the seat of extensive tuberculous deposit, you will find the resonance of percussion increased on the opposite unaffected side, which is now doing double duty. Extensive anæmia, by lessening the quantity of blood in the lungs, may also give rise to slight extra resonance on percussion.

Dulness.—This consists in a diminution of the pulmonary resonance, and may be slight, considerable, or complete, according as more or less air enters the affected part. In

dulness, the intensity is diminished, the pitch raised, the duration shortened, and the quality hardened. Dulness always indicates a decrease in the normal proportion of air in the part, and is an important physical sign in a number of diseases, as in pneumonia, tuberculosis, œdema of the lungs, etc.

Flatness.—This indicates the total absence of air, so that there is no proper pulmonary resonance, and its sound resembles that produced by percussing the thigh. We have examples of this when we percuss over fluid contained in the pleural or pericardial serous cavities, or when tumors are developed in the thorax, etc.

Tympanitic Resonance.—This is marked by the absence of proper pulmonary *quality* in the characters of its resonance; the type being the resonance of a tympanitic abdomen on percussion; in intensity it exceeds normal pulmonary percussion, and is lower in pitch. As a physical sign in thoracic affections it usually indicates the presence of air in the pleural cavity, as in pneumo-thorax. In this affection we have air contained, not in small vesicles, but in a large free space, and hence we have not the vesicular, but the tympanitic quality in the sound.

Vesiculo-Tympanitic Resonance.—By this term (introduced by Prof. A. Flint), it is meant to denote a resonance in which we have both the tympanitic and vesicular qualities. It is lower pitched, but more intense than normal pulmonary resonance, and is present, when the increase of the volume of the lung, as in some cases of emphysema, is so great as to dilate and render extremely tense the thoracic walls.

Amphoric Resonance, unlike tympanitic resonance (which gives an impression of fulness), is suggestive of shallowness or emptiness; it resembles the sound produced by flapping the cheek when the mouth is closed, and fully but not forcibly inflated. It is most frequently heard over a large superficial cavity, having thin, tense walls, and hence is usually indica-

tive of phthisis. In case of pleuro-pneumonia, a sound more or less amphoric in character is sometimes heard.

Cracked-Pot Resonance is usually, though not invariably, heard in connection with amphoric resonance. It resembles the sound produced by striking the hands, loosely folded across each other, against the knee, the contained air being suddenly forced out between the fingers. If there exists a pulmonary cavity of large size, with thin walls, communicating freely with a large bronchial tube, the chest walls being at the same time particularly yielding, forcible percussion, with the patient's mouth open, will yield cracked-pot resonance. Dr. Hughes Bennett states that a cracked-pot resonance may be elicited in various diseases of the chest, and even when the chest is perfectly sound. I have never obtained true cracked-pot resonance unless over a pulmonic cavity, or in pneumothorax.

Auscultatory Percussion.—This is a combination of auscultation and percussion. It was first brought to the notice of the profession by Drs. Camman and Clark in 1840.

Their method of performing it was as follows: Press the objective end of a stethoscope, constructed expressely for this purpose* (while the ear-piece is accurately fitted to the ear), firmly and evenly on the surface, directly over that portion of the organ or tumor to be examined which is most superficial; then let percussion be performed in the usual way, one or two

* This instrument is a solid cylinder of wood, shaped in the direction of the woody fibres, six inches in length, and ten or twelve lines in diameter; furnished with an ear-piece which will allow nearly the whole cylinder to pass through it, so that it may apply directly to the tube of the car, without change of medium. To avoid as much as possible the sound of the thoracic walls, as is desirable in some cases, this instrument has been modified, by reducing it at its objective extremity to a truncated wedge, leaving the other extremity as before. This is applied between the ribs so as not to touch them, and at the same time approach somewhat nearer the object under examination.—N. Y. Jour. of Med. & Surg., July, 1840.

inches from the point at which the stethoscope is applied. The percussion sound communicated to the ear in this manner far exceeds in intensity and distinctness the same sound when communicated through the medium of the air. The slightest change in pitch and quality is also readily appreciated.

The benefits claimed for auscultatory percussion by its originators are: "*First,* That the heart can be measured in all but its antero-posterior diameters, under most, perhaps all circumstances of health and disease, with hardly less exactness than we should be able to do if the organ were exposed before us.

"*Second,* That the outlines of the liver can be traced with much greater certainty than by ordinary percussion, in circumstances of health; and to circumscribe it in many conditions of disease in which ordinary percussion is not applicable.

"*Third,* That the dimensions of the spleen can be ascertained in circumstances that baffle ordinary percussion.

"*Fourth,* That by it we can mark the superior, inferior, and external limits of the kidneys. Ascites presents no obstacle to the measurement of these organs: and from enlarged spleen the left kidney is easily distinguished."

LESSON IV.

Auscultation.

Auscultation is a kind of eavesdropping, for in it you bend your ear to catch the significance of sounds that come from hidden quarters, which no one may open. As in percussion, so here, auscultation may be *immediate,* when the ear is applied directlv to the bared or thinly covered surface; and *mediate* when the sounds are conducted from the surface to the ear through a tubular instrument called a stethoscope.

Both of these methods have their exclusive advocates, but as each has its own advantages, I would strongly recommend your becoming equally practised in the use of them both. *Per se,* immediate auscultation answers best for pulmonary examinations; but in examining the heart, where, as in valvular murmurs, you have to analyze circumscribed sounds, your ear will often be confused by the noise of its near neighbor, the left lung, or by other cardiac sounds than the one under examination, and you will find the stethoscope then assists you by its measurably excluding the sounds which have their seat outside the rim of the chest-piece. Besides, there are cases where the state of the surface may make you very reluctant to bring your ear into immediate contact with the patient's person, while in other cases you may not be allowed to do so, and in such of course, you would have recourse to the stethoscope.

Stethoscopes of great variety as to form and material have been recommended, each inventor claiming some superiority

in principle or shape for his own instrument. They may all, however, be referred to two general classes; viz., flexible and solid. I regard as the best representatives of these two classes those devised by the late Dr. Camman of this city. For general use I would recommend his Binaural Stethoscope, which has connected with the cup that is applied to the surface, two tubes that fit into each ear. It requires some practice to become adepts in its use; but once accustomed to it, you will, I think, find no other stethoscope superior to it, for it closes both ears to every other but the desired sounds.

In the performance of auscultation, as of percussion, certain precautions are requisite in order to insure accurate results. The following rules will be found of service:

First. The chest should in immediate but not in mediate auscultation, have some thin, soft covering, which will not interfere with the transmission of sound, or itself produce any from the respiratory movements of the thoracic walls to which it is applied. A soft towel smoothly spread over the surface answers this purpose very well.

Second. The position of the patient should be regulated in the same manner as for the performance of inspection, care being taken that the parts should be in a state of perfect repose. The position of the examiner should be as unrestrained as possible, and he should by all means learn to concentrate his attention on the sounds which reach his ear.

Third. The ear, or the stethoscope, should be applied firmly, but not forcibly, to the surface, and when the stethoscope is used, it is important that its rim press equally and evenly on the part.

Fourth. As in percussion, corresponding parts of the two sides of the chest should be compared together, nor should the examination be considered complete unless it has included the entire chest. In acute, thoracic affections, auscultation should be frequently repeated.

Fifth. The examination should be commenced, if possible, during ordinary respiration. The patient should then be directed to take a full inspiration, then to cough, and then again to breathe naturally. The latter is to some very difficult when under examination, and they sometimes seem equally incapable of completing a full inspiration. In such instances our object may be attained by performing the act ourselves, and requesting the patient to imitate it, or by directing him to sigh. If these expedients fail, direct him to cough continuously for some moments, whereupon a full, clear inspiration follows, and he does involuntarily what his previous efforts have failed to accomplish.

Let us now consider the important subject of the nature and causes of the respiratory sounds in health.

If the ear be applied to a healthy chest during a respiratory act, a soft, breezy murmur will be heard, composed of two periods; one corresponding to the movements of inspiration, and the other, both fainter and shorter, to that of expiration, and which are termed respectively the inspiratory and the expiratory sounds of respiration. The elements of these sounds are analogous to those of percussion, and hence we express them by the terms *Intensity*, *Pitch*, *Quality*, and *Duration*, to which, however, we now add a fifth, *Rhythm*, which refers to the relative succession of the two periods in the respiratory act. As might be expected, we find definite proportionate variations among these elements, normally present in the various portions of the respiratory tract, and these constitute distinct varieties of respiratory sounds, which are named after those regions in which they occur in health. Thus we speak of vesicular, bronchial, tracheal, and laryngeal respiration, each of these sounds having its own proper intensity, quality, pitch, etc. The left infra-clavicular region in a healthy chest furnishes the purest vesicular respiration; the inter-scapular region, the best normal bronchial respiration;

and by placing the stethoscope or ear over the larynx and trachea, you will hear the tracheal and larnygeal breathing. These integral elements, *i. e.*, pitch, quality, duration, etc., are due to differences in the volume and velocity of the current of air on the one hand, and on the other to the nature of the obstructions which it meets in its entrance or exit through the pulmonary passages. Every complete respiratory sound, however, whatever its component characters, yet retains its division into inspiratory and expiratory murmurs.

Of all the normal respiratory sounds, that which stands first in importance is the *Vesicular*. The best representative type of the normal vesicular murmur is found in the left infra-clavicular space, where you will hear during inspiration a sound of a gentle rustling character, most marked at the end of the act. The intensity and duration of this murmur vary in healthy persons, and form the least important of its elements. Its pitch, however, should be low. The expiratory sound when present (it being absent in four out of five healthy persons when their attention is not directed to their respiration) is much shorter than the inspiration, its relative duration varying in different individuals; its intensity is less than in inspiration, its pitch higher, and its quality harder; the breezy or vesicular character of the inspiratory sound being wanting. These two sounds follow each other so closely that they may be said to be continuous, and this fact is itself an important element of normal vesicular respiration. It should be noted here, however, that the normal respiratory sounds do not exactly correspond in the two infra-clavicular regions. On the right side the pitch of the inspiratory sound is higher than on the left, and less breezy in quality; while the expiration is more pronounced and prolonged in duration. This disparity should be taken into account in all doubtful cases, such as in suspected small pulmonary consolidations. Age also affects the characters of normal vesicular respiration in a well-determined

and peculiar degree, taking for the standard in comparison the above-mentioned characters of respiration with healthy middle-aged individuals. In infancy, the intensity of both the inspiratory and expiratory sounds is increased, while the other elements remain the same. In old age, on the other hand, the intensity is diminished, the duration in inspiration shortened, and the expiration prolonged. Sex likewise modifies the respiratory sounds. As a rule, both inspiratory and expiratory sounds have greater intensity, and the latter is oftener present in the left infra-clavicular space, in the female than in the male. In females the inspiratory sound has more intensity in the upper part of the chest, while in males it is more intense in the lower and posterior portions. If the ear or stethoscope be applied over the larynx or trachea, a sound will be heard with inspiration and expiration, which sound is termed *normal laryngeal* and *tracheal respiration.* From vesicular respiration it differs in the following respects: in *quality* it is wholly *tubular;* the inspiratory sound is more intense and higher in *pitch;* it ends a little before the inspiratory act is completed, so that a slight *interval* occurs between the inspiratory and the expiratory sounds. On the other hand, the expiratory sound is tubular in quality, higher in pitch, and as long, or longer, than the inspiratory.

The characters of the next variety or *bronchial* respiration are very important to the auscultator from their common occurrence and significance in disease. They are those of tracheal respiration, only in a less marked degree, being less tubular in quality, while the interval between the inspiratory and expiratory sound is shorter.

Now, the more thoroughly you learn these varieties in healthy respiration, the better you will be prepared to understand what respiratory sounds are abnormal. Very often you will hear in disease, what you recognize as one of the normal sounds, but you know that this familiar sound has in this case

a serious import, because it is not the natural sound of that locality. But you may also hear sounds whose character differs from any normal type. We may, however, say in general that abnormal sounds consist in changes from the standard of healthy respiration as regards the three elements of *intensity*, *rhythm*, and *quality*, thus:

In *Intensity* the respiratory murmur may be	1st. Exaggerated or increased. 2nd. Diminished or feeble. 3rd. Absent or suppressed.
In *Rhythm* the respiratory murmur may be	1st. Interrupted. 2nd. The interval between inspiration and expiration be prolonged. 3rd. Expiration be prolonged.
In *Quality* the respiratory murmur may be	1st. Rude, termed rude respiration. 2nd. Bronchial " bronchial " 3rd. Cavernous, " cavernous " 4th. Amphoric, " amphoric "

Alterations in Intensity.

Exaggerated Respiration differs from the normal vesicular respiration only in an increase in the intensity and duration of the respiratory sounds. It is sometimes called puerile respiration, from its resemblance to the respiration of children, and is present in a part where respiration is more active than usual, owing to deficient action elsewhere, as in the upper part of one lung whose lower lobe is consolidated by pneumonia, or similarly where one lung does the duty of its fellow which is solidified by the pressure of a pleuritic effusion.

Diminished or **Feeble Respiration** differs from normal vesicular respiration only in a diminution in the intensity and duration of the respiratory sounds. It may arise from any cause which interferes directly or indirectly with the expansion of the lung, or which diminishes the elasticity of its tissue. Of the first condition we have illustrations in affec-

tions which restrain the movements of the thoracic walls, as pleuritic pain, rheumatism, paralysis, etc.; or when there is some obstruction to the entrance of air into the lungs, such as in diseases of the larynx, trachea, or bronchial tubes, or again when a pleuritic effusion or a tumor presses the lungs back from the chest walls, though not to a degree sufficient to prevent all air from entering them. Of the second condition we have examples in pulmonary emphysema, and in incipient tubercular deposits.

Absent or **Suppressed Respiration** occurs whenever, from some cause, the play of the lung is suspended; and this may be either from external pressure, as when the lung is forced against the spinal column by the presence of fluid or air in the pleural cavity; or, on the other hand, when a complete obstruction of any bronchus prevents the air from either entering or leaving the lungs.

Alterations in Rhythm.

Interrupted Respiration.—In health the respiratory and expiratory sounds are even and continuous, with a brief interval between each respiratory act; but this may be altered in disease, and both sounds, especially the inspiratory, may have an interrupted or jerking character, termed by some "cog-wheel respiration." We have examples of this kind of respiration in asthma, pleurodynia, first stage of pleurisy, and incipient phthisis. It is most frequently associated with phthisis, and may be due probably to some gelatinous mucus adhering to the walls of the finer bronchial tubes, which, though not sufficient to produce rale, still obstructs the free ingress and egress of the air.

Prolonged Interval between Inspiration and Expiration.—Instead of these two sounds closely succeeding one another, they may be separated by a distinct interval. When this occurs, either the inspiratory sound is shortened, or the

expiratory sound is delayed in its commencement. In the first instance it is the result of pulmonary consolidation, as in tubercle; in the second, the elasticity of the pulmonary tissue is impaired, as in emphysema, no sound being heard during the first portion of the expiratory act.

Prolonged Expiration.—Here the ratio between normal inspiration and expiration is inverted. The expiration at times is twice or three times as long as the inspiration.

It is always due to a want of freedom in the egress of air from the lungs. The most common, and therefore, practically speaking, the most important cause of prolonged expiration is tubercular deposit in the lung. Excessively prolonged expiration is to be met with in vesicular emphysema, and this is to be distinguished from the prolonged expiration of phthisis by its *pitch*, which in emphysema is *low*, lower than the inspiration, while in phthisis it is *high*, higher than the inspiration, and tubular in quality.

Alterations in Quality.

Rude Respiration.—This is termed (by Prof. A. Flint) *broncho-vesicular respiration.* In this variety both inspiratory and expiratory sounds lose their natural softness; the breezy or vesicular quality is lost; the sounds are higher pitched and more tubular in character, while the expiration has more intensity, higher pitch, and longer duration than the inspiration. Rude respiration always indicates more or less consolidation of lung tissue. In normal vesicular respiration, the sounds produced by the vibrations of the air in the air cells and finer bronchi obscure that produced in the trachea and larger bronchial tubes (healthy lung substance being a poor conductor of sound); but so soon as any portion of lung becomes consolidated, the vesicular element of the respiratory sound is diminished and the bronchial element

becomes prominent; this change constitutes rude respiration. It embraces every degree of modification between complete bronchial respiration on the one hand, and normal vesicular breathing on the other; the increase in bronchial characters corresponding with the degree of consolidation. Rude respiration is of practical value, principally in the diagnosis of incipient phthisis.

Bronchial Respiration is characterized by an entire absence of all vesicular quality. The inspiratory sound is high pitched and tubular in character; the two sounds are separated by a brief interval; the expiratory is still higher pitched and more intense than the inspiratory, is as long or longer, and of the same tubular quality. Whenever this modification of the respiratory sound is present, where in health normal vesicular murmur should be heard, consolidation of lung substance may be inferred. Consequently it is an important diagnostic sign in many pulmonary affections, such as pneumonia, phthisis pulmonalis, pulmonary apoplexy, etc.

Cavernous Respiration.—In some respects this resembles bronchial respiration, and it is often difficult to distinguish one from the other. Some distinguished auscultators declare that this sign does not exist.

Its distinguishing characteristics are, on inspiration, a soft, blowing, low-pitched sound, non-vesicular in character: as a rule, the expiratory sound is lower pitched than the inspiratory, and is always prolonged and puffing.

For its production, there must be a cavity of considerable size in the lung substance, having free communication with a bronchial tube. The cavity must be empty and near the surface, its walls must be sufficiently flaccid to expand with inspiration, and collapse with expiration. This sign is most frequently met with in the third stage of phthisis.

Amphoric Respiration.—Whenever the respiratory sound has a musical intonation or metallic quality, resembling that

produced by blowing gently into the mouth of an empty bottle, it is called amphoric.

The amphoric character accompanies both acts of respiration, especially the expiratory.

It may be due to phthisical or other excavations in the lung substance, or to an opening from the bronchial tube into the pleural cavity, giving rise to pneumo-thorax. In both cases the sound is produced by vibrations of air in a cavity, which are excited by a current of air from a bronchial tube. The cavity in the lung substance which gives rise to amphoric respiration must be of large size, empty, with tense, firm walls, so as not to collapse with expiration, and it must communicate freely with a large bronchial tube.

This sign is mainly of importance in the diagnosis of advanced phthisis and pneumo-thorax.

This completes the history of the most important alterations in the natural respiratory sounds produced by disease. With few exceptions they are no new sounds, but are heard in the healthy chest, and become significant of disease only when heard in unnatural locations.

LESSON V.

Abnormal or Adventitious Sounds.

THE sounds which are now to be considered are termed Adventitious, because they are not heard in health, but are found in disease, either accompanying the normal respiratory sounds, or wholly supplanting them. They vary much in their character according to their origin; that is, whether they are caused by changes in the texture of the lung itself, or in its investments; and hence, in order to appreciate their significance when present, you should know well beforehand their seat and mode of production.

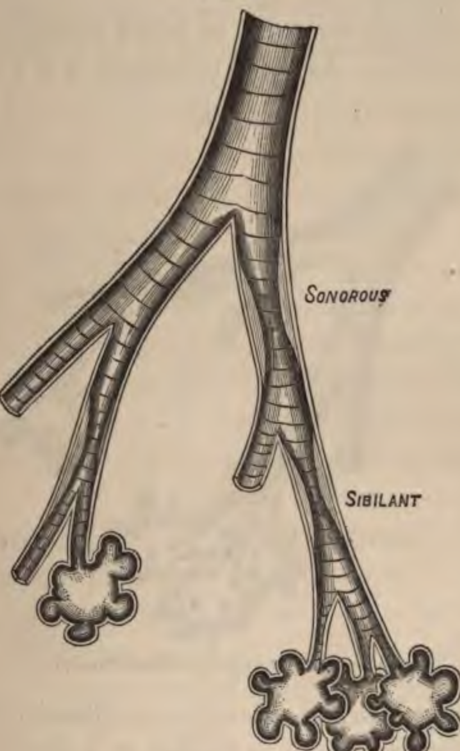
These sounds which originate in the air passages, or in cavities abnormally communicating with them, are called *rales*, or *rhonchi*. Of the two, I prefer, and shall use, the term rale, and would classify the varieties of rales which meet us in practice, as follows:

Rales.	Dry rales.	Sonorous rales.
		Sibilant rales.
	Moist rales.	Mucous rales (large and small).
		Sub-crepitant rales.
		Crepitant rales.
		Gurgles (large and small).
		Mucous click.

A rale may originate in the trachea, in the bronchi, large or small, in the air cells, or in abnormal cavities situated either within or without the lung substance. It may be produced within the air tubes, either by a diminution of their calibre,

by the vibrations of viscid matter collected in them, or by the air bubbling through fluid present in the bronchi and in the air vesicles, or in larger or smaller cavities. A rale may be either dry or moist in its character, and may be audible either in inspiration or in expiration, or in both.

Fig. 3.



Sonorous and Sibilant Rales.—DACOSTA.

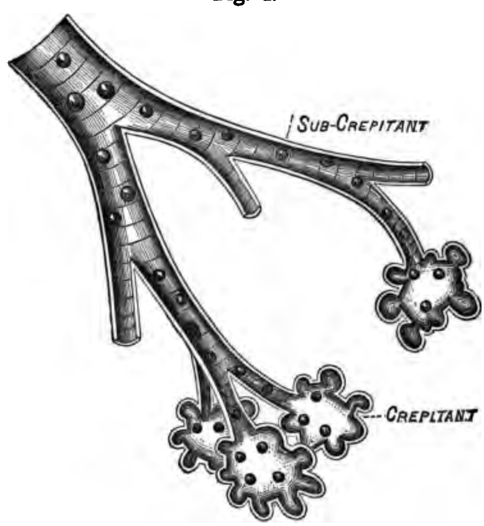
Dry Rales are divided into sonorous and sibilant, according to the pitch and quality of the sound; if a rale is low pitched and snoring in character, it is termed sonorous; if high pitched and whistling, it is termed sibilant.

The *Sibilant* rale may be heard during both inspiration and expiration. It recurs irregularly, and sometimes is so high

pitched as to become hissing in its character. Its seat is the smaller bronchi, and it is caused either by the narrowing of these tubes from thickening of the mucous tissues lining them, or from the spasmodic contraction of their muscular coat; or it may be owing to the vibrations of viscid mucus adhering to their walls. In most instances it may be temporarily removed by violent coughing.

The *Sonorous* rale may also be heard during both inspiration and expiration. As above mentioned, it is a low pitched,

Fig. 4.



Crepitant and Sub-crepitant Rales.—Dacosta.

snoring sound, which varies, however, in intensity from a slight rale to one loud enough to be audible at a distance from the chest. It has for its seat the larger bronchial tubes, and is produced by conditions of those tubes similar to those which cause sibilant rales in the smaller bronchi; namely, lessened calibre from tumefaction of the mucous tissues, or from spasmodic contraction, or from pressure on the tube from without, by a tumor, an exudation, or a deposit; or it may be owing to the vibrations of a thickened fold of the lining membrane,

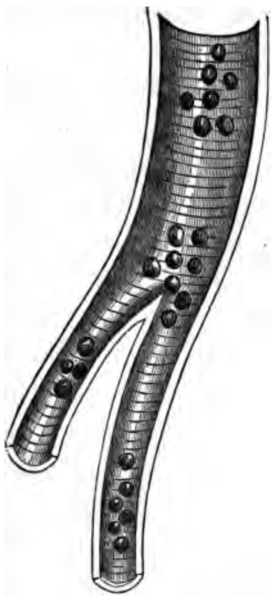
or of viscid mucus adhering to it. This rale is specially frequent in bronchitis and spasmodic asthma, though it may be present in almost every pulmonary disease.

Moist Rales.—Under this head may be included the *crepitant, sub-crepitant,* and *mucous rales.*

The *Crepitant* rale is composed of a number of quick, minute, and sharp sounds of a crackling nature. They also persist for some time in the spot where they are first heard; they are audible only *during inspiration,* and do not vary in their character. This rale undoubtedly has its seat in the air cells and interlobular spaces. There are two views as to its mode of production: one, that it is the result of air bubbling through fluid in the vesicles and interlobular spaces; the other, that at the end of each expiration a viscid secretion glues together the walls of the air cells, the separation of which on inspiration gives rise to the crackling sound. It may probably be produced in both these ways. This rale is the characteristic sign of pneumonia, though it is not infrequent in some forms of pulmonary congestion, and in œdema of the lungs.

The *Sub-crepitant* rale is a moist, bronchial sound, caused by the breaking of minute air bubbles of equal size and comparatively few in number. Its seat is the smallest bronchi, and the liquid through which the air passes may be mucus, serum, pus, or blood. It differs from the crepitant rale in the larger size of the bubbles, and is heard in expiration as well as in inspiration. This rale is present in a number of affections. When heard on both sides of the chest posteriorly, it indicates capillary bronchitis, and it is also characteristic of the resolving stage of pneumonia, so as to be termed the "rale redux." When present only in the apex of a lung, it indicates commencing phthisis. It accompanies the effusion of blood into the bronchial tubes, and is sometimes present in œdema of the lungs.

Fig. 5.



Mucous Rales, Large and Small.

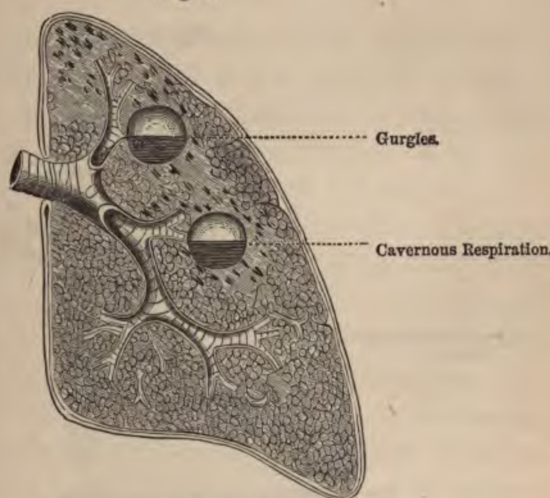
The *Mucous* rale is also a moist bronchial sound produced in the same way as the sub-crepitant rale; that is, by the passage of air through mucus, pus, serum, blood, etc.; so that the sound may be termed distinctly liquid. It differs, therefore, only from its seat being in air tubes of larger size than the ultimate capillary bronchi in which originate the sub-crepitant rale; but as these tubes are themselves both small and large, so we have "small," or what is termed "fine" mucous rales, and "large" or "coarse" mucous rales. Like the sub-crepitant rale, you may hear it during both inspiration and expiration, and it is modified, or entirely removed, by the act of coughing. Mucous rales occur in bronchitis during the stage of secretion; in bronchial hemorrhage; whenever pus makes its way into the air passages from an abscess,—in short, whenever the bronchial tubes become partially filled with fluid of any kind, and hence we do not intend to imply by the term "mucous" that it is only the mucous secretion itself which causes the rale. If these rales, whether fine or coarse, are restricted to a circumscribed space at the apex of a lung, they indicate that the bronchitis is of phthisical origin.

Gurgles are produced in larger or smaller cavities partially filled with liquid, which is agitated by the passage of air from bronchial tubes that communicate freely with the cavity below the surface of the fluid. This sound, though distinctly liquid, yet has a peculiar hollow, metallic quality. Gurgles may be heard both in inspiration and expiration; and according to the size of the cavity will they be "large" or "small." Small

gurgles resemble large mucous rales, but may be distinguished from them by their above-mentioned hollow, metallic character.

The most frequent cause of pulmonary cavities is the softening and expectoration of a cheesy pneumonia; but they may be owing to abscess, gangrene, perforating empyema, and excessive dilatation of the bronchial tubes. When pulmonary cavities exist without gurgles, it may be due either to the cavity being filled with fluid, or to its containing no fluid; or the level of the fluid may be below the opening of the bronchial tubes.

Fig. 6.



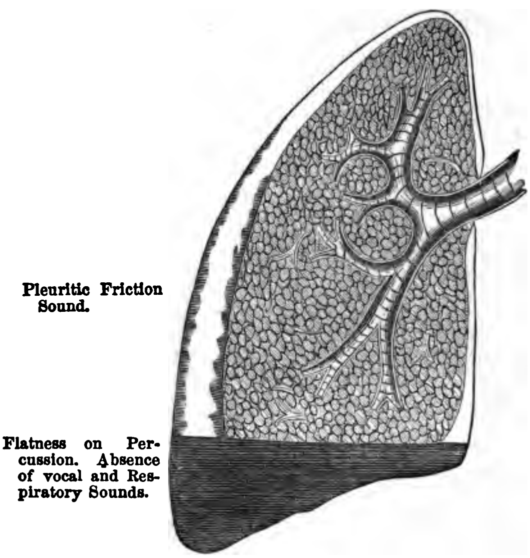
Cavernous Respiration and Gurgles.

Mucous Click.—This is a single quick, clicking sound, not removed by coughing, and which resembles an isolated subcrepitant rale. Authors differ as to the theory of its production. It appears to me to be due to the sudden and forcible passage of air through a small bronchus, the sides of which have been brought together at one or more points, either by external pressure, or by their being agglutinated from within.

This happens when a consolidated lobule presses unequally upon a bronchus, and excites at the same time a local inflammation of the mucous membrane of the part, with its consequent viscid secretion. It is therefore important as a symptom of incipient phthisis.

Pleuritic Friction Sounds.—These also are properly included among the adventitious respiratory sounds. In health, the two surfaces of the pleural membrane, being smooth, and

Fig. 7.



Roughening of the Pleura, and Slight Pleuritic Effusions.

moistened by their natural secretion, play noiselessly upon each other during the movements of each respiratory act. When therefore an inflammation roughens either one or both of these surfaces, or dries up their natural secretion, it gives rise to the friction which produces those characteristic sounds to which the above name is given. These sounds are few in number compared to crepitant rales, and consist of one, or of a series of abrupt, jerking, rubbing noises, manifestly super-

ficial, and which are commonly heard over a limited extent of surface. They vary much in intensity, from a sound scarcely audible, to one of extreme loudness; and they usually accompany both inspiration and expiration, being seldom heard with expiration alone.

There are several varieties of pleuritic friction sounds, termed, respectively, grazing, rubbing, grating, creaking, and crackling; all of which belong to the clinical history of pleurisy.

The grazing variety occurs at the onset of pleurisy, when dryness of the membrane is the only change yet produced. As soon as there is dulness on percussion, it is replaced by the rubbing or crepitating variety, and therefore is of such short duration, that it is not often heard, but may be more frequently noticed in the circumscribed pleurisy which is sometimes occasioned by tubercular deposits. The other varieties are the forms in which the pleuritic friction sound most commonly presents itself; and they occur both in the stage of plastic exudation and in the stage of absorption.

Sometimes the respiratory sound is attended by sounds resembling rales, which are doubtful both as to their situation and significance.

They are of two kinds: First, creaking sounds not unfrequently heard at the apices of the lungs, produced either by the creaking of pleuritic adhesions, or by crepitations in lung tissue. Second, dry crumpling sounds, resembling those produced by inflating a dried bladder, probably (as Laennec supposed) produced by the forcible distension of large air-sacs in emphysematous lungs.

LESSON VI.

Auscultation of the Voice.

THIS is another method of obtaining information as to the condition of the lungs and their investing membranes, and it is based on the fact that the vibrations of the voice are not only transmitted outwards, but also downwards through the trachea and bronchi, to all parts of the lung. This normal vocal resonance, as it is termed, varies greatly in its character, according to where it is heard and through what media it has passed ere it reaches the ear or stethoscope; and hence its varieties are named after the parts where they are heard in health.

If the stethoscope be placed over the larynx or trachea of a healthy person, while speaking, the voice will be transmitted to the ear, imperfectly articulated, and with a force, intensity, and concentration, almost painful. This is called Natural Laryngophony and Tracheophony.

At the upper part of the sternum, and between the spines of the scapula, it is heard less intense, more diffused, and less distinctly articulated; and this is termed Bronchophony. But when you apply the ear over lung substance itself, the vibrations of the voice become distant, diffused, and without any approach to articulation. This being the sound peculiar to lung tissue, the term normal vocal resonance is generally applied exclusively to *it*. Its intensity is always greater on the right than on the left side, especially in the infra-clavicular region. But it also varies considerably in this respect

in different healthy persons. It is more intense in those who have low-pitched voices, and also more in thin than in fleshy persons; while in females there is, not unfrequently, no difference. You cannot rely on the vocal resonance of any one region of the chest, as trustworthy evidence by itself, either of health or of disease; the indications being furnished only by comparisons between the corresponding parts of the two sides, after allowance is made for natural differences.

In making your examination for this purpose, the readiest way is to direct the patient to count one, two, three, etc. The modifications of the vocal resonance which you will find indicative of disease will consist of changes in intensity. 1. Its intensity may be diminished; or, 2. it may be increased; and I would clasify them as follows:

1. Diminished intensity. .	*a* Vocal sounds may be weak or feeble.
	b " " " suppressed or absent.
2. Increased intensity. .	*a* Vocal sounds may be simply exaggerated.
	b Its resonance may be of the character termed Bronchophony.
	c " " " " Pectoriloquy.
	d " " " " Egophony.
	e " " " " Amphoric Voice.

The varieties included under the head of diminished resonance require but little explanation. The vocal resonance may be faint or altogether wanting. The first often occurs in bronchitis with free secretion; in plastic pleuritic effusions, and occasionally, when there is extreme pulmonary consolidation. There is absence of vocal resonance in pneumo-thorax, and in copious serous pleuritic effusion. The modifications, however, which accompany increased intensity are more varied and complex.

Exaggerated Vocal Resonance differs from normal vocal resonance only in a slight increase of intensity. It denotes a moderate amount of solidification of lung tissue, and is chiefly of importance in the diagnosis of tubercle.

The characters of **Bronchophony** I have already described. Its significance lies in its being found in localities where it is not heard in healthy conditions; its near, strong, and distinct sound reaching the ear, when we should hear instead the distant, muffled, and inarticulate vibration of normal vocal resonance. This could not have happened without the spongy tissue of the lung being first changed to a denser texture, better adapted to transmit the sound from the larger bronchi, and hence it denotes complete pulmonary consolidation in those parts where it is abnormally present. The best examples of bronchophony are usually met with in the second stage of pneumonia.

Pectoriloquy (so named by Laennec, its discoverer) is a complete transmission of the voice to the ear. The words spoken are heard distinctly articulated. It closely resembles the resonance heard over the larynx, and is usually limited to a small space in the chest, where it also may, or may not, have a hollow, ringing character. It was formerly believed always to indicate the presence of a pulmonary cavity, but auscultators are now agreed that this is not necessarily the case in every instance, but that it is sometimes simply an exaggerated bronchophony; the only distinction between these two being that bronchophony is the transmission of the voice, pectoriloquy that of the speech. Well defined pectoriloquy is not a common phenomenon.

Egophony is the name given by Laennec to another form of vocal resonance, which is distinguished by its tremulous, nasal character, suggestive of the bleating of a goat. It also is a modification of bronchophony. Laennec considered it a sign of a limited amount of serous effusion in the pleura, over solidified lung. It is rarely heard, and is of not much significance when heard.

Amphoric Voice is a term applied to the vocal resonance, whenever, in addition to its being of a hollow, metallic char-

acter, it has a distinct musical intonation. This musical sound follows the voice, is of high pitch, and is not articulated like pectoriloquy. It is sometimes produced in large cavities within the lung, but is more particularly a sign of pneumo-hydro-thorax.

In addition to vocal resonance, we have a true whisper resonance, the modifications of which by disease may afford us some valuable hints (as was first pointed out by Prof. A. Flint). If while practising auscultation on a person in health (as I should strongly advise you to do with one another while studying this whole subject), you direct him to count in a loud whisper, you will usually hear a soft, blowing sound, accompanying each whispered word, which varies in intensity in different persons.

As a rule, it is heard only at the upper portion of the thorax, and is loudest over the primary bronchi. Dr. Flint calls this sound the normal bronchial whisper, and he classes its abnormal modifications into *exaggerated bronchial whisper*, *whispering bronchophony*, *whispering pectoriloquy*, *cavernous whisper*, and *amphoric whisper*.

The exaggerated differs from the normal whisper in having greater intensity and higher pitch. It indicates slight solidification of lung tissue. In whispering bronchophony, the blowing sound is intense, the pitch high, and the sound seems near to the ear, while it is found not only where it should be in health, but also in more distant parts, where it is never normally present, and like vocal bronchophony indicates complete consolidation of the lung substance. The cavernous whisper is a hollow, low-pitched, blowing sound. It is, when present, a trustworthy indication of a cavity, and requires similar conditions for its production with those of cavernous respiration. In whispering pectoriloquy, the whispered words are distinctly audible at the surface of the chest, and this constitutes a more sure indication of a cavity than

vocal pectoriloquy. The character and the significance of the amphoric whisper are the same as those of the amphoric voice.

Another of the adventitious sounds is that which is termed *metallic tinkling*, its name being sufficiently descriptive of its character. It sounds like the dropping of a pin or a small shot into a metallic vessel. A single one, or a series of tinkling sounds, may be produced by the act of speaking, or by the movements of inspiration and expiration; but it is especially consequent on the act of coughing.

This sound announces the existence either of a very large pulmonary cavity, or of pneumo-hydro-thorax. Dr. Walsh regards it as the echo of a bubble bursting in a liquid, shut up in a spacious cavity which also contains air.

Resonance of Cough.—If while auscultating a healthy person you cause him to cough, you will find the act accompanied by a quick, sharp, indistinct sound, which jars through the whole chest. Over the larynx and trachea the cough is hollow, and varies in pitch and intensity with the voice of the individual. The modifications of the cough sound in disease are termed bronchial, cavernous, and amphoric. Bronchial cough has a quick, harsh character, attended by a marked thrill or fremitus of the chest. Cavernous cough is hollow and metallic (commonly it is termed sepulchral). It may be accompanied by gurgles, and its resonance is sometimes transmitted to the ear of the auscultator with painful intensity. Amphoric cough is a loud resounding sound, of metallic character, but not forcibly transmitted to the ear. It conveys the impression of a large empty space. These varieties of cough are heard under the same conditions as the corresponding varieties of respiration. They are not of much utility in diagnosis.

LESSON VII.

A Synopsis of Physical Signs in the Diagnosis of Pulmonary Diseases.

Bronchitis.

Acute and Chronic Bronchitis affecting the Larger Tubes.

Inspection.—The form and movements of the chest are not visibly altered.

Palpation.—Vocal fremitus is normal; occasionally a distinct bronchial fremitus is communicated to the surface of the chest.

Percussion.—Pulmonary resonance is normal, unless there is a very considerable accumulation of mucus in the bronchial tubes, in which case the normal resonance is diminished, in the lower and posterior regions.

Auscultation.—The respiratory murmur is feeble or temporarily suppressed in the lung tissue corresponding to the affected tubes. In the dry stage, sibilant and sonorous rales may be heard on both sides of the chest (as shown in fig. 3). In the stage of secretion along with the sibilant and sonorous rales, mucous rales, large and small, are heard on both sides of the chest (see fig. 5). These rales are inconstant, coming and going, and changing their situation. When the rales are intense and abundant, they altogether mask the respiratory murmur. In some cases of slight bronchitis of the larger tubes, there are no distinct rales, but the respiration has a sonorous character. The *vocal resonance* is normal.

Capillary Bronchitis.

Capillary Bronchitis, or bronchitis affecting the ultimate or capillary bronchial tubes.

In addition to the signs belonging to simple bronchitis, auscultation discovers, if the disease is extensive, that the vesicular murmur is weakened or suppressed, and instead, sub-crepitant rales (see fig. 4) are heard on both sides of the chest, accompanied by sibilant rales of a hissing character. If the sub-crepitant rales are *abundant*, they indicate *very positively* that the capillary bronchial tubes are inflamed; but they may be present to a limited extent posteriorly, owing to the gravitation of fluid from the larger to the smaller tubes. If they are confined to the base or apex of one lung, with resonance on percussion, the bronchitis is either of an emphysematous or tubercular origin.

Percussion is normal, or it may be slightly exaggerated.

Vocal Resonance is normal.

Differential Diagnosis of Bronchitis.—The diagnosis of bronchitis of the larger tubes is readily made; but capillary bronchitis may be confounded with pneumonia, and with acute or chronic phthisis. It is distinguished from pneumonia, by normal or exaggerated resonance on percussion, by the existence of sub-crepitant rales on both sides of the chest, and by the absence of bronchial breathing.

The distinctive diagnosis between capillary bronchitis and phthisis, will be considered under the head of Phthisis.

Dilatation of Bronchi. (*Bronchicatasis.*)

Bronchicatasis is usually associated with fibrous induration of lung or with emphysematous enlargement, and is recognized by the following physical signs:

Inspection shows defective, expansive movements of the chest, and prolonged, labored expiratory movements.

Palpation.—Vocal fremitus varies, rhonchial fremitus frequently present.

Percussion is tubular, unless the accumulation of thick secretion gives rise to obstruction of the tubes, and consequent local solidification of the lung; in such cases, there is temporary dulness. This dulness is to be distinguished from the dulness of pneumonia, by its temporary character, and by the variations in vocal fremitus. From pneumonic consolidation it is distinguished by the presence of cavernous and amphoric breathing.

Auscultation.—The normal respiratory sounds are more or less deficient over the entire chest, except after free expectoration, when they may be heard harsh and loud, where a moment before they were inaudible. The respiratory sounds are accompanied by a variety of rales, chiefly sonorous, unless the tubes have just been emptied, when large mucous rales or gurgles are also present. The sounds in any portion of the lung are constantly varying in character, altered by cough and by full inspiration. The rapid change in the physical signs consequent upon profuse expectoration is a very important evidence of a dilated bronchus.

Pulmonary Emphysema.

Inspection in a well-marked example of this disease discovers alterations in the shape and movements of the chest. The sternum is often abnormally prominent as if from congenital deformity. There is bulging of the infra-clavicular and mammary regions, which gives to the upper portion of the chest a more rounded appearance than in health, or, as it is called, "barrel-shaped." The shoulders are elevated and brought forwards; there is more or less anterior curvature of the spine, and the person appears to stoop. The lower portion of the chest seems contracted, and the intercostal spaces are widened in the upper, narrowed in the lower spaces. In

some instances in which the general symptoms of emphysema are well marked, the lung is atrophied instead of being abnormally dilated; and no bulging or prominence of the chest occurs either general or local.

The movements of the chest walls are also altered; at the upper portion, expansion on inspiration is diminished or entirely wanting; the whole chest moves vertically up and down with inspiration and expiration, as if it were passively lifted from the shoulders, and composed of one solid piece; while below, the chest, instead of being dilated with inspiration, is contracted. The respiratory efforts are labored, and the breathing is chiefly abdominal.

Palpation.—The vocal fremitus varies; it may fall below, or it may equal, or exceed, the average of health. The apex beat of the heart is often not perceptible in the precordial space; sometimes it is felt much lower than its normal position.

Mensuration shows a marked increase in the antero-posterior diameter of the chest.

Percussion.—The intensity of the percussion sound is increased; the pitch is lowered; the pulmonary quality of the sound is greatly diminished, and it becomes what has already been described as vesiculo-tympanitic. The percussion note is not materially affected either by forced inspiration or forced expiration.

Auscultation.—As a rule, the inspiratory sound is either short and feeble, or actually suppressed, and the expiratory sound is greatly prolonged; the ratio of the two sounds being as 1:4 instead of 4:1. The pitch of both inspiratory and expiratory sounds is lower than in health.

In some extreme cases of emphysema, the respiratory sounds are of equal length, greatly exaggerated in intensity, and of a harsh, sibilant quality, the harsh quality, undoubtedly, being due to diminution in the calibre of the minute bronchial tubes.

Vocal Resonance varies greatly; sometimes it is diminished or altogether absent; at others, its intensity is greatly increased. The heart sounds are feeble, and in rare instances the organ is pushed downwards towards the epigastrium.

Differential Diagnosis.—The only disease with which emphysema is liable to be confounded is pneumo-thorax. The distinction, however, is not very difficult, for in emphysema the percussion sound, although tympanitic, still retains a pulmonary quality, and there is a vesicular element to the respiratory sound; while in pneumo-thorax the percussion sound has a complete tympanitic character, and the respiration, if audible, is amphoric. Besides, pneumo-thorax affects only one side, emphysema both.

Spasmodic Asthma (during the Paroxysm).

Inspection shows labored respiration.

Palpation, vocal fremitus normal.

Percussion is normal or exaggerated.

Auscultation.—The rhythm of the respiratory murmur is jerking and irregular; sometimes it is exaggerated, at others it is suppressed. Sibilant and sonorous rales, of a high pitched, hissing and wheezing character, are diffused over the whole chest, often loud enough to be heard at a distance.

Vocal Resonance is normal.

Acute Pneumonia. (*Lobar.*)

The physical signs of pneumonia vary with its different stages.

First Stage, or **Stage of Engorgement.—Inspection.**—The movements of the affected side are more or less restrained.

Palpation, vocal fremitus normal.

Percussion.—There is slight dulness over so much of lung

tissue as is involved in the pneumonic inflammation, the degree of dulness depending upon the amount of exudation into the lung substance.

Auscultation.—In the early period of the engorgement before exudation takes place, the respiratory murmur is diminished in intensity in the affected part, and exaggerated in other portions of the affected lung, as well as in the healthy lung. As soon as exudation takes place, the inspiratory sound is accompanied by the *crepitant rale,* the characteristic sign of the first stage of pneumonia. In some cases, especially when pneumonia is developed in connection with acute articular rheumatism, crepitation never occurs.

Fig. 8.

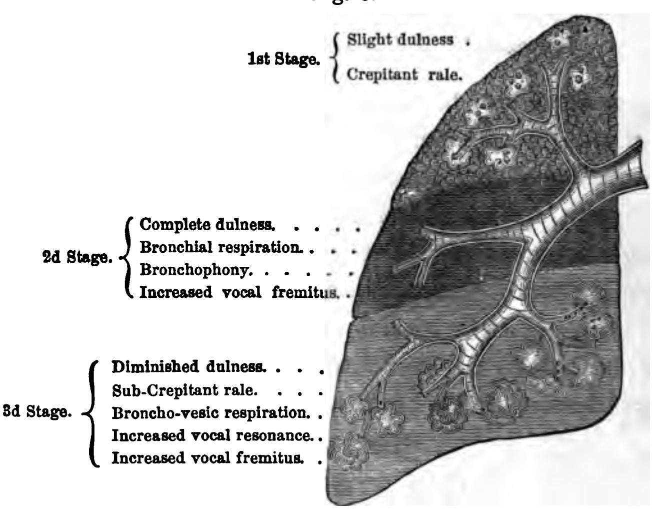


Diagram illustrative of the Physical Signs of the Three Stages of Pneumonia.

Second Stage, or **Red Hepatization.**—**Inspection.**—The expansive movements are diminished on the affected side, and increased on the healthy.

Palpation.—As a rule, vocal fremitus is increased; occasionally, when the hepatization is extensive, it is diminished.

Percussion.—There is marked dulness over a space corre-

sponding to the consolidated lung tissue, and increased resonance over the healthy portion of the affected lung. The relation of the resonance and dulness is not affected by a change in the position of the patient. Absolute dulness or flatness on firm percussion very rarely exists.

Auscultation.—As the air cells become completely filled with exudation, the crepitant rales cease, and *bronchial respiration* is heard over the solidified lung tissue. The more complete the consolidation, the more intense and tubular is the bronchial respiration.

Vocal Resonance.—There is marked bronchophony over all that portion of lung which is the seat of pneumonic consolidation. The heart sounds are transmitted to the surface with unnatural intensity. The characteristic physical signs of this stage are *dulness on percussion, bronchial breathing,* and *bronchophony.*

Third Stage, or **Grey Hepatization.**—The physical signs in the early part of this stage are the same as those of the second stage. They are simply the signs of consolidation. In the latter or resolving part of this stage, *percussion* shows progressive diminution in dulness. It is often, however, a long time before normal pulmonary resonance is perfectly restored.

Auscultation.—The bronchial respiration of the second stage gradually gives place to rude (or broncho-vesicular) respiration, and this in turn approximates to, and at length ends in, normal vesicular breathing. As the bronchial respiration diminishes, the sub-crepitant and crepitant rales, or "rales redux," are developed, and remain audible until resolution is complete.

Bronchophony gives place to exaggerated vocal resonance, and that in turn to *normal* vocal resonance. The physical signs of chronic pneumonia will be considered in connection with phthisis.

Lobular Pneumonia.—The physical signs of this variety of pneumonia will be described under the head of pulmonary phthisis.

Pulmonary Œdema.

In œdema of the lungs *inspection* and *palpation* furnish no positive information.

Percussion.—There is more or less dulness on percussion (never however complete) diffused over the posterior surface of the chest on both sides, and marked at the most depending portion of the lungs.

Auscultation.—Respiratory murmur is feeble, sometimes almost entirely absent. With the inspiratory sound, crackling rales are heard over the seat of the œdema; the crackling resembles somewhat the crepitant rale of pneumonia, but is distinguished from it by its liquid character.

Differential Diagnosis.—Pulmonary œdema may be confounded with the first stage of pneumonia, with hydro-thorax, and with capillary bronchitis. It is distinguished from pneumonia, as we mentioned above, by the liquid character of the crackling rales, and by its occurring on both sides, at the most depending portion of the lungs,—pneumonia usually being confined to one lung; from hydro-thorax, by the presence of rales, and by the level of the dulness not being changed by a change in the position of the patient; from capillary bronchitis, by the slight dulness on percussion which attends it, and by the absence of the rales in the larger bronchial tubes.

Pulmonary Gangrene.

The physical signs of pulmonary gangrene are often obscure and never distinctive. They are those of local consolidation followed by the evidences of the breaking up of lung tissue, and the formation of cavities in the lung substance. There are no special signs indicating the nature of the disorganizing process; sometimes it is preceded by the signs of

pneumonia; generally it is accompanied by the signs of bronchitis, and late in the disease there are physical evidences of the formation of cavities in the lung substance.

Pulmonary Hemorrhage.

The physical signs of a slight hemorrhage from the lungs are very obscure. No information as to the seat or amount of the hemorrhage is furnished by inspection, palpation, or percussion. Auscultation may, however, indicate the spot at which the hemorrhage occurs, by the presence of moist rales. If the hemorrhage is profuse, and accompanied by pulmonary apoplexy, abundant moist rales will be heard at the seat of the effusions, and they remain audible until coagulation takes place, or the effusion is removed. When pulmonary apoplexy occurs, it is usually found in the lower and posterior portions of the lungs. If the nodules are few and small, there will be no positive physical evidences of their situation. When the nodules are large and lie superficially, percussion will give more or less dulness over a limited space corresponding to the extent of the hemorrhage, and on auscultation there will be a diminution or absence of the respiratory murmur. When the extravasation is situated near a large sized bronchial tube, bronchial breathing and increased vocal resonance are heard, and there is also increase in the vocal fremitus.

Pulmonary Cancer.

Miliary Disseminated Cancer of the lung cannot be distinguished by physical examination from simple bronchial catarrh.

In the nodular or massive variety—

Inspection shows the affected side retracted and the respiratory movements impaired.

Palpation gives diminished vocal fremitus

Percussion gives absolute dulness over the space corresponding to the cancerous mass.

Auscultation.—The respiratory sounds may be feeble, or absent, or if a large open bronchus is intimately connected with the cancerous mass, bronchial respiration may be heard.

Differential Diagnosis.—The only disease with which pulmonary cancer is liable to be confounded is pleurisy with serous effusion. In cancer, however, the percussion dulness does not begin at the bottom of the chest, as is the case in pleurisy; in cancer, the dulness is most marked in front, whereas in pleurisy, it is greatest behind; in cancer, you will be able to detect one or more isolated spots of resonance in the dull space, while in pleurisy the dulness is uniform over all the space occupied by the fluid.

Pulmonary Collapse.

Complete collapse of large portions of lung may be produced either by bronchitis or compression. There are no physical signs to indicate its occurrence, unless the collapsed lung is in contact with the chest wall, and then the signs are not very distinctive. Usually there is over the space where it occurs, some dulness on percussion, localized bronchial breathing, and increased vocal fremitus. When there is collapse of only a few vesicles, a deep inspiration may bring out a crepitant rale, audible during a few respirations, and then heard no more. Congenital atelectasis gives rise to no physical signs, unless there is marked inspiratory dyspnœa and retraction of chest walls.

Pulmonary Congestion.

There are no recognizable physical signs of simple pulmonary congestion unless it is associated with pulmonary œdema, or bronchial hemorrhage.

It may be suspected when extreme dyspnœa comes on suddenly after violent physical exertion, or during the inhalation of highly rarefied air met with in high altitudes, especially if, with the dyspnœa, you have the physical signs of pulmonary œdema, and a watery blood-stained expectoration.

Some auscultators have regarded intensification of the second sound of the heart over the pulmonary arteries as a diagnostic physical sign of pulmonary congestion; but this evidence is fallacious, for greater intensity of the second pulmonary sound may be merely relative, and due to weakness of the aortic sound.

LESSON VIII.

A Synopsis of Physical Signs in the Diagnosis of Pulmonary Diseases.—Continued.

Pleurisy.

THERE are three recognized varieties of pleurisy, *Acute, Sub-Acute, and Chronic, or Empyema.* In acute, there is but little liquid effusion; in sub-acute, the liquid effusion is abundant, often completely filling the pleuritic cavity; in empyema the effusion is purulent, comparatively small in quantity, and usually circumscribed. I shall consider the physical signs of the three varieties separately.

Acute Pleurisy

May be divided into four stages,—a dry stage, a plastic stage, a stage of liquid effusion, and a stage of absorption.

Dry Stage.—*Inspection* shows a diminution in the respiratory movements, especially in expansion of the affected side. They are also quick, catching, and irregular. *Palpation, mensuration,* and *percussion,* yield only negative results.

Auscultation.—The respiratory murmur is feeble, jerking, and interrupted; occasionally a grazing, friction sound is heard over the seat of the pleuritic inflammation.

Stage of Plastic Exudation.—Inspection.—The respiratory movements of the affected side are still more diminished; while those of the healthy side are increased.

Palpation.—Vocal fremitus is diminished.

Percussion.—There is more or less dulness over the seat of the plastic exudation. If the dulness is marked, the plastic matter is abundant. The dulness will be less at the end of a full expiration.

Auscultation.—The respiratory murmur over the seat of the pleuritic inflammation is feeble or entirely absent, and a rubbing or crepitating friction sound is heard, most distinctly at the end of the inspiratory act, as shown in fig. 7.

Vocal Resonance.—The intensity of the vocal resonance is diminished.

Stage of Liquid Effusion.—Inspection.—In acute pleurisy the quantity of liquid effusion is generally small, as shown in fig. 7 ; consequently there is no dilatation of the affected side. The jerking movements of the dry and plastic stage now cease, and there is no visible motion at the seat of the fluid accumulation.

Palpation.—Vocal fremitus is absolutely suppressed over the effused fluid.

Percussion.—When the patient is sitting or standing, there is flatness on percussion, from the base of the lung on the affected side, to the level of the fluid, as shown in fig. 7. The line of the flatness may be changed by changing the position of the patient.

Auscultation.—The respiratory sounds below the level of the fluid are suppressed, above they are exaggerated. The friction sounds disappear where the fluid effusion prevents the pleural surfaces from coming in contact with each other, but above the confines of the fluid they continue to be heard, as shown in fig. 7.

Vocal Resonance.—Below the level of the fluid, the vocal sounds are feeble or entirely abolished.

Stage of Absorption.—This stage is marked by the gradual return of pulmonary resonance on percussion, and of the normal vocal and respiratory sounds. As the fluid effusion

disappears, creaking friction sounds are audible for a brief period.

Sub-Acute Pleurisy.

In this variety of pleurisy, the pleural cavity may be partly or completely filled with fluid. Besides the fluid there is a moderate amount of plastic exudation, which thickens and roughens the pleural membranes. When the cavity is partly filled, the presence and amount of the effusion is determined by the same physical signs that mark the effusive stage of acute pleurisy. When the pleural sac is distended by the fluid accumulation, the lung is compressed against the spinal column, and the capacity of the pleural cavity is increased in every direction, giving rise to important modifications in the physical signs.

Fig. 9.

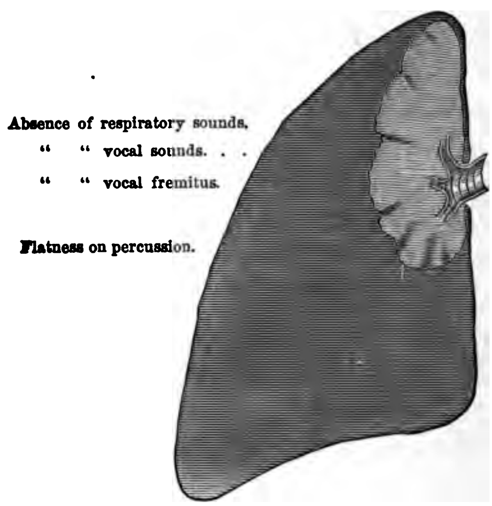


Diagram showing the Pleural Cavity completely filled with Fluid, the Lung being compressed.

Inspection shows perfect immobility of the chest walls, with general enlargement of the affected side; the intercostal spaces are even with the ribs, or bulging, and the cardiac impulse is visible in an abnormal position.

Mensuration shows an enlargement of the affected side, both in its circumference and in its antero-posterior diameter; the enlargement is greatest over the false ribs, the affected side often measuring one or two inches more than the healthy.

Palpation shows the vocal fremitus to be wanting.

Percussion.—There is universal flatness on percussion over the affected side, the flatness extending beyond the natural limits of the lung. Under the clavicle, the percussion sound sometimes has a tympanitic quality.

Auscultation.—There is entire absence of all respiratory and vocal sounds over the affected side, except over the apex of the compressed lung; here not unfrequently are heard bronchial respiration and bronchophony; the bronchial respiration emanating from the compressed lung is diffused, and may be heard over the whole of the affected side. The respiratory sound over the healthy lung is exaggerated.

In the **Fourth Stage**, or stage of absorption, *inspection* informs us that the enlargement of the affected side is disappearing; that the intercostal spaces are regaining their normal condition, and that the respiratory movements of the chest walls are returning, although restricted.

Palpation shows a gradual return of vocal fremitus.

Mensuration shows a gradual diminution in the measurement of the affected side, until it becomes even less than the opposite side.

Percussion.—The percussion sound gradually recovers its normal resonance; first, at the upper, and then at the lower portion of the pleural cavity; sometimes in the inferior portion it never regains its normal resonance, owing to the great accumulation of solid, plastic material, or condensation of lung tissue.

Auscultation.—The respiratory sounds are again heard, at first weak and distant; gradually they become more distinct, and sometimes harsh in character. As the absorption of the

[illegible] - In a case of ac. pleurisy right side [illegible] my case (patient [illegible]) at Stokes 1876 - The tension of fluid was
so great [illegible] otherwise [illegible] the chest, that the pleural side became a virtual hydrophone - and the
[illegible] pectoriloquy were transmitted to the ear as though a lung solid from pneumonia - everything
[illegible] disappeared in a few hours after a trial [illegible]

fluid takes place, and the two surfaces of the pleura again come in contact, a friction sound returns of a creaking, crepitating character, which remains audible for a variable period. The *vocal resonance* is at first bronchophonic, then exaggerated, and ultimately you get normal vocal resonance. The heart, with the adjacent abdominal viscera, returns to its normal position, sometimes with singular promptness. If, as sometimes happens, the lung remains permanently impervious to air, then there is a permanent loss of motion on the affected side, and there is no return of the respiratory or vocal sounds, while dulness on percussion is persistent. A portion of the lung (usually the upper portion) sometimes becomes partially pervious to air; when this is the case, the percussion sound over it will have a tympanitic quality, the vocal resonance will be exaggerated, and the respiratory sound coarse and blowing.

Empyema.—The physical signs of empyema are the same as those of sub-acute pleurisy, when the pleural cavity is partially filled with fluid. In the majority of the cases of empyema that have come under my observation, a change in the position of the patient has not caused a change in the level of the fluid, owing probably to the firm adhesion that takes place between the pleura pulmonalis and pleura costalis, above the level of the prevalent accumulation. Excessively abundant empyematous effusions sometimes pulsate rhythmically with the heart, "*pulsating empyemata.*"

Differential Diagnosis.—The diagnosis of pleurisy, in the majority of cases, is easily made; yet in all its different varieties there is some danger of confounding it with other diseases.

In the **Dry Stage** of acute pleurisy, it may be confounded with pleurodynia, and intercostal neuralgia; it is distinguished from them by the presence of the grazing friction sound, by the deep-seated character of the pain, and by the absence of tenderness on pressure over the seat of pain.

The **Plastic Stage** of pleurisy on the left side may occa-

sionally be confounded with the plastic stage of pericarditis. It is readily distinguished from it by the cessation of the friction sound during a temporary suspension of the respiratory movements.

The **Effusive Stage** may be confounded with consolidation of the lung from pneumonia and tubercular infiltration, with an enlarged liver or spleen extending upwards, and with cancerous deposits in the lungs. It is distinguished from pneumonia and tubercular consolidation by the bulging of the affected side, by the absence of vocal fremitus, by the flatness of the percussion sound, by the change in the level of the fluid on change in the position of the patient, and by the absence of all vocal and respiratory sounds. The blowing respiration that is sometimes heard over a pleural cavity filled with fluid differs from the true tubular or bronchial breathing of pulmonary consolidation, in being *more diffused* and *deep-seated*, and not being accompanied by any moist sounds. In phthisical consolidation, the progress of the physical signs is usually from above downwards; in effusion, they advance from below upwards. Besides, pulmonary phthisis of an entire lung does not exist without involving the opposite lung; while any amount of pleuritic effusion may exist on one side, while the other remains unaffected.

The physical signs of the stage of absorption will rarely be confounded with any other disease. Hypertrophy of the liver, enlarging upwards, is distinguished from effusion into the right pleural cavity by the existence of pulmonary percussion, and audible respiratory murmur at the posterior part of the chest. Deep inspiration also increases the area of the normal percussion, and normal respiratory sound at the inferior portion of the pleural cavity; it exerts no such influence when the loss of resonance and respiratory murmur depends upon pleuritic effusion.

Enlargement of the spleen affects but slightly the vocal or

respiratory sounds at the inferior portion of the left pleural cavity; it causes no protrusion of the intercostal spaces, and does not, like pleuritic effusion, push the heart to the right, but raises it upwards.

Pneumo-Thorax.—Inspection shows distension of the affected side, widening and bulging of the intercostal spaces, and immobility of the chest walls, contrasting forcibly with the costal movements of the healthy side.

Palpation.—Vocal fremitus is diminished, or altogether wanting. *Mensuration* shows marked increase in the measurement of the affected side.

Percussion elicits a tympanitic resonance of an amphoric or metallic quality, over the whole of the affected side. When the dilatation of the chest is excessive, the adjacent viscera are more or less displaced, the tympanitic percussion sound assumes a muffled character, and extends considerably beyond the normal limits of the pleura.

Auscultation varies according to the amount of air contained in the pleural cavity. If the cavity is distended with air, so that the lung is completely compressed, the vocal and respiratory sounds are altogether absent, and the heart sounds are feebly transmitted through the distended pleura; if the quantity of air is small, the respiratory sounds are weak and distant, and the vocal sounds indistinct.

Hydro-pneumo-Thorax usually is the result of perforation of the pleura; a communication being established between a bronchial tube and the pleural cavity. The physical signs of this condition are a combination of those of pleuritic effusion and pneumo-thorax. As in pneumo-thorax, inspection reveals dilatation of the affected side, widening and bulging of the intercostal spaces, immobility of the chest walls, and displacement of the heart and adjacent viscera. There is entire absence of vocal fremitus.

Percussion.—When the patient is sitting or standing, there will be tympanitic resonance on percussion from the summit of the affected side to the level of the fluid, and flatness below; the relation of the flatness and tympanitic resonance changing with the change in the position of the patient.

Fig. 10.

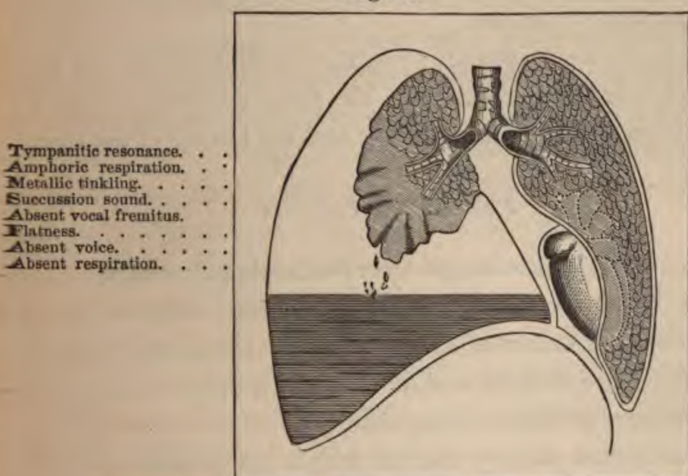


Diagram illustrative of the Physical Signs of Hydro-pneumo-Thorax.

Auscultation.—Below the level of the fluid there is entire absence of all the respiratory and vocal sounds; above its level, there is usually amphoric respiration and metallic tinkling.

The characteristic physical sign of this disease is the *succussion sound,* which is a metallic, splashing sound, produced by abruptly shaking the chest while the ear is resting on its surface.

The respiration on the healthy side is exaggerated. When pneumothorax is secondary to advanced phthisis, the lung often remains adherent to the chest wall, and great distention of the affected side is prevented. Pneumothorax is sometimes simulated when there is complete catarrhal obstructions to the main bronchi.

Pulmonary Tuberculosis.

The formation of tubercle in the lungs is only attended by physical signs, when its development is accompanied by pulmonary catarrh. A most abundant formation of miliary tubercle is often found in lungs which during life gave no physical signs of disease.

When physical signs are present, they differ in no way from those of extensive bronchitis. The diagnosis rests almost entirely upon the general symptoms and the history of the case.

Pulmonary Phthisis.

The best definition of this term is chronic pulmonary consolidation, which tends to fibrous induration with or without ulceration. It differs in its physical signs according as the consolidations are miliary and disseminated, or massive and involving large portions of lung tissue.

Disseminated miliary nodules which are phthisical, do not admit of discovery any more easily than those of a tubercular origin—the physical signs in both instances are those of capillary bronchitis.

The physical signs of phthisis depends—

First, Upon localization of bronchial rales and consolidation of lung tissue.

Second, Upon decrease in the volume of the lung by induration and shrinking.

Third, Upon the formation of cavities.

There are three recognized stages in pulmonary phthisis—

First, A stage of bronchial catarrh and consolidation of lung tissue.

Second, A stage of induration, shrinking, and softening of lung tissue.

Third, A stage of exudation, and the formation of cavities.

First Stage—Inspection affords little information unless the consolidation is extensive, and confined to one apex, where expansion in the infra and supra-clavicular region of the affected side will be diminished, and there will be some flattening of the upper part of the chest wall noticeable.

Palpation.—By palpation you will often detect deficient expansion in the infra-clavicular region of the affected side when it cannot be detected by inspection. There is also slight increase in the vocal fremitus; this increase, however, is less significant when it occurs on the right side than on the left.

Percussion.—The difference in the percussion note in the infra-clavicular region on the two sides, rather than the quality of the sound, is important.

If the consolidation is slight and superficial, there will be slight raise in the pitch of the percussion sound on the affected side; but if healthy or emphysematous lung tissue intervene between the consolidated lung and the chest walls, the percussion sound may be normal, or extra resonant, over the affected portion; to detect pulmonary consolidation under such circumstances, the percussion blow must be forcible, and directed from and not towards the trachea. If doubts exist, the percussion should be performed at the end of a full inspiration, and at the end of a full expiration. As consolidation increases, the pitch of the percussion sound rises, and its clearness diminishes, until, in some cases, absolute dulness is reached.

Auscultation.—The results of auscultation vary. In the early stage of progressive pulmonary consolidation, the respiratory sound in the infra and supra-clavicular region of the affected side is weak or suppressed at some points, and exaggerated at others. It may also be jerking, wavy, or "*cogged-wheel*" in its rhythm, and rude or bronchial in its quality. The inspiratory sound loses its soft breezy character, and becomes high pitched and tubular; while the expiratory becomes higher pitched than the inspiratory, and is prolonged. Prolonged

expiration, however, if unattended with any alteration in quality, is insignificant. The value of these states of the respiration correspond to their position. If they exist above and are imperceptible below the second interspace, they are seriously significant. Localized mucous or sub-crepitant rales heard over a limited space at the apex of the lung are always important signs of phthisis, and indicate the development of broncho or catarrhal pneumonia; they are often present before any appreciable change in the respiratory murmur occurs. At first they are more or less obscure in proportion to the weakening of the respiration; gradually they become more distinct and numerous as the pulmonary consolidation increases. The heart sounds over the affected lung will be increased in intensity.

Vocal resonance is subject to so many variations as to render it almost valueless as a means of diagnosis. Exaggerated vocal resonance at the left apex is of some importance.

Second Stage.—The diminution in the bulk of the solidified lung tissue which occurs in this stage, is attended by contraction of the corresponding region of the chest, and new auscultatory signs referable to the stage of softening are developed.

Inspection.—You will now perceive a greater frequency in the respiratory acts, and marked depression above and below the clavicles, and a marked deficiency in local expansion, especially during a a forced inspiration.

Percussion elicits a wide-spread and more intense dulness, and it often assumes a wooden or tubular character.

Auscultation.—The respiration grows more intensely bronchial, and moist crackling rales of a metallic character are heard. The rales sometimes are sticky in character, and do not change or disappear in coughing. Vocal resonance and vocal fremitus are extremely variable, and cannot be relied upon.

Third Stage.—The physical signs of this stage have connection with the formation of cavities, and the diagnosis of a cavity

demands that it be near the surface, not smaller than a walnut and contain for the most part air.

Inspection.—The signs obtained by inspection remain as in the second stage, except that the rapidity of the respiration is increased, and the depression of the supra and infra-clavicular regions becomes more marked, and there is more complete absence of the respiratory movements during the respiratory acts.

Palpation is still unreliable, although when a cavity is large and superficial, vocal fremitus is increased, and sometimes a gurgling fremitus is detected. A large cavity is also sometimes attended by a bulging of that part of the chest wall which had previously been sunken.

Percussion.—The percussion sound varies according to the condition of the cavities and the lung tissue surrounding them. If the cavity is of small size and surrounded with consolidated lung tissue, the percussion sound will be absolutely dull, or tubular in quality; if a layer of healthy lung tissue intervene between the chest walls and the cavity, the latter being full, gentle percussion will give normal resonance, while forcible percussion will elicit deep-seated dulness. Large, empty, superficial cavities with thin tense walls, yield an amphoric or "cracked pot" resonance.

Auscultation.—If the cavity is empty and communicates freely with a bronchial tube, and no healthy lung tissue lies between it and the chest walls, the respiration will be either cavernous or amphoric, as shown (Fig. 6); *cavernous*, when the cavity is of small size, with flaccid walls, so that they collapse with expiration and suspend with inspiration; *amphoric*, when the cavity is large and surrounded with consolidated lung, so that its walls are tense and do not collapse in expiration. If fluid has accumulated in the cavity in sufficient quantity to rise above the opening into it, large or small sized gurgles will be heard (as shown in Fig. 6); metallic tinkling will sometimes be heard over cavities of large size. Vocal resonance may give

either pectoriloquy, or be amphoric, bronchophonic, weak, or entirely absent. Small cavities partially filled with fluid, deeply seated, do not give rise to the signs characteristic of cavities, but simply furnish blowing respiration and small-sized gurgles, which resemble very closely mucous rales.

In *advancing* phthisis, a cavity may be presumed to exist at the point where the bronchial breathing is most intense, and the moist sounds are most metallic in quality. The difficulty of diagnosis between phthisis and some forms of pleurisy and pneumonia, has already been indicated.

HEART AND THORACIC AORTA.

LESSON IX.

Topography of the Heart and Aorta.—Physiological Action of the Heart.

THE diagnosis of many cardiac diseases rests upon our knowledge of the relations of the different compartments and orifices of the heart to the chest walls. It is therefore necessary to be familiar with this relationship, and with the physiological acts which constitute a complete cardiac pulsation, before we can intelligently study the physical signs involved in the diagnosis of these diseases.

By referring to fig. 1, the relations of the heart to the adjacent viscera will be readily appreciated.

In the healthy chest, the auricles are on a line with the third costal cartilages. The *right auricle* extends across the sternum, a little beyond its right border. The *left auricle* lies deeply behind the pulmonary artery. The middle portion of this auricle corresponds to the cartilage of the third rib. The *right ventricle* lies partly behind the sternum, and partly to the left of it; its inferior border is on a level with the sixth cartilage. The *left ventricle* lies for the most part to the left of the sternum, between the third and fifth intercostal spaces. Only a narrow strip of the ventricle is visible anteriorly. The heart, then, as a whole, extends vertically from the second space to the sixth costal cartilage, and transversely from about half an inch to the right of the sternum to within half an inch of the left nipple. Posteriorly, the base lies opposite the sixth and seventh dorsal vertebræ. The left ventricle, the greater part of the left auricle, and a

large portion of the apex of the right ventricle, lie to the left of the sternum. Behind the sternum lie a greater portion of the right auricle and ventricle, and a small portion of the left. To the right of the sternum lie a portion of the right auricle, and the upper portion of the right ventricle. The whole of the anterior surface of the heart is overlapped by the lungs, except a triangular space corresponding to the lower portion of the right ventricle.

The **Surface Measurements** of the heart are as follows: Vertical measurement from the second interspace to the fifth interspace, five inches; from the median line to the left, on the third rib, two and a half to three inches; on the fourth rib, from three and a half to four inches; in the fifth interspace, from three to three and a half inches.

Relative Position of the Valves.

The **Tricuspid Valve** lies behind the middle of the sternum, on a line with the articulation of the cartilages of the fourth ribs with the sternum.

The **Mitral Valve** lies behind the cartilage of the fourth left rib near the sternum.

The **Aortic Valves** lie behind the sternum, a little below the junction of the cartilages of the third ribs with the sternum, and near its left edge.

The **Pulmonary Valves** lie behind the junction of the third left rib with the sternum. A circle of an inch in diameter with its centre at the left edge of the sternum, a little below the junction of the third rib with the sternum, will include a portion of all these four sets of valves.

The **Aorta** arises from the left ventricle behind the sternum, opposite the third intercostal space, and passes from left to right; the ascending portion of the arch comes to the right of the sternum between the cartilages of the second and third ribs; in this part of its course it is within the pericardial sac;

thence the transverse portion of the arch crosses the trachea just above its bifurcation, at the centre of the first bone of the sternum, on a line with the lower margin of the articulation of the cartilages of the first ribs with the sternum; thence the descending portion passes backwards and downwards towards the left side of the third dorsal vertebra, and rests ultimately upon the left side of the bodies of the fifth and sixth dorsal vertebræ. The arch of the aorta approaches most closely to the chest walls, at the point where the arteria innominata is given off; that is, on a line with the junction of the cartilage of the second right rib with the sternum.

The **Pulmonary Artery** arises from the right ventricle to the left and behind the sternum, on a line with the junction of the cartilages of the third ribs with the sternum; it ascends upwards and backwards about two inches, when it bifurcates opposite the second costal cartilage.

The **Pericardial Sac** encloses the heart, and may be represented as a cone, extending from the second to the seventh left costal cartilage. The base of the cone rests on and is attached to the diaphragm, and the apex embraces the lower two inches of the great vessels. The larger portion of the sac lies to the left of the median line, and is farther from the anterior chest walls superiorly than it is inferiorly.

Physiological Action of the Heart.

The actions which constitute a complete cardiac pulsation are the contraction, dilatation, and rest of each of its cavities. These acts are attended by alteration in the form, size, axis, and position of the heart. The contraction of the ventricles, or their *systole*, as it is termed, constitutes the active state of the heart; as soon as this ceases, the muscular tissue relaxes, the cavities enlarge, and the ventricles are said to dilate, this process constituting what is termed the *diastole* of the heart.

Auricular Systole.—The heart's action begins with the contraction or *systole* of the auricles. By it a small additional quantity of blood is propelled into the ventricles; but its contraction is too slight, either to empty the auricles or to cause the dilatation of the ventricles. Its duration is about the eighth part of an entire beat of the heart, the mitral and tricuspid valves being open, while the aortic and pulmonary valves are closed, as shown in the diagram fig. 12.

Fig. 12.

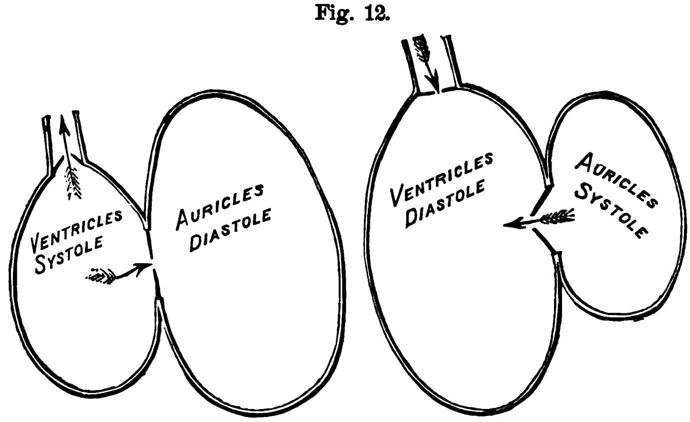


Diagram showing the Changes that occur in the Valves and Cavities of One Side of the Heart during a Cardiac Pulsation.

Auricular Diastole.—The dilatation or *diastole* of the auricles is a passive movement; these cavities are gradually distended by the blood which enters from the venæ cavæ and pulmonary veins, the mitral and tricuspid valves being closed, and the aortic and pulmonary being open, as is shown in the diagram (fig. 12). It continues from the termination of one auricular systole to the commencement of the next.

Ventricular Systole.—The contraction or *systole* of the ventricles succeeds immediately upon that of the auricles; or, in other words, the sudden distention of the ventricles by the blood propelled into them, during the systole of the auricles, is rapidly followed by the contraction of the ventricles. During

their contraction the vertical diameter of the heart is diminished, the *apex* is approximated to the base, and describes a spiral motion from right to left, and from behind forwards, coming in contact with the walls of the thorax between the cartilages of the fifth and sixth ribs on the left side, where the impulse of the heart is felt. With the ventricular systole the blood is propelled with considerable force from the ventricles into the aorta and pulmonary arteries. The mitral and tricuspid valves are closed, and the aortic and pulmonary valves are open, as is shown in the diagram (fig. 12). It occupies about one-half of the entire beat of the heart.

Ventricular Diastole.—The dilatation or *diastole* of the ventricles immediately succeeds their contraction, during which the blood flows in full stream from the auricles into the ventricles; the mitral and tricuspid valves are open, and the aortic and pulmonary are closed (as shown in fig. 12); the heart becomes elongated, and it assumes the shape and position which it had before the systole. The duration of the diastole occupies about one-fourth of the entire beat of the heart; the second sound of the heart is synchronous with it.

Period of Repose.—From the termination of the diastole of the ventricles, to the commencement of the auricular systole, the ventricles are in a state of perfect rest, their cavities remaining full but not distended; the duration of this period is less than one-fourth the entire beat of the heart. As soon as the auricles become distended, they contract, and another heart action commences. If the duration of all these movements, from the commencement of one pulse to the commencement of another, be divided into five equal parts, two-fifths will be occupied by the contraction of the ventricles; one-fifth by dilatation of the ventricles, and the remaining two-fifths by the period of rest and the contraction of the auricles.

In order that you may readily appreciate the whole series

and sequence of these elements in the heart's action, I will employ the diagram of Prof. W. T. Gairdner.

It consists of two circles. The physiological action of the heart, apart from its external manifestations, is indicated by the inner circle and its divisions; the external rim is occupied by marks corresponding to the sounds; and the different

Fig. 13.

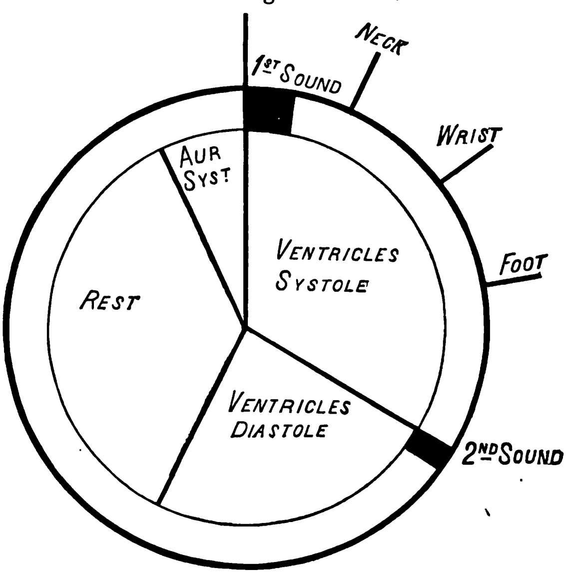


Diagram showing the Physiological Action of the Heart in Connection with its External Manifestations.—GAIRDNER.

pulses or impulses are portrayed by lines projecting from the circumference of the outer circle. The physiological facts which constitute a cardiac pulsation are thus apparent. "Beginning with the contraction of the auricles, then that of the ventricles, then the rapid dilatation of the ventricles, and then the pause, succeeded by the contraction of the auricles again." "It is apparent also that in this succession of action, the phenomena which we can appreciate externally are a little later than the real commencement of the heart's action; they do not

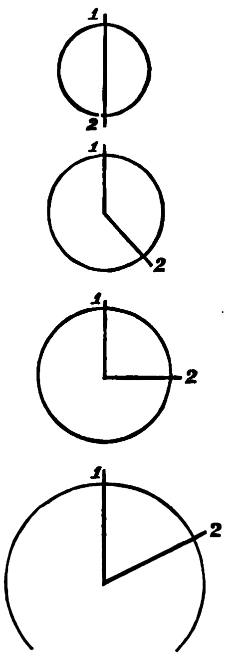
correspond to the very first beginning of movement, for, before there is either sound or impulse, the contraction of the auricles has already taken place; and when the impulse is perceptible in the carotid, the contraction of the ventricles has commenced, and by the time it is perceptible in the foot, it is almost complete. During the diastole of the ventricles and the period of rest all external manifestations are lost." This series of actions constitutes what is called the *rhythm of the heart.*

There are certain difficulties that are apt to occur in estimating the normal rhythm of the heart. The entire period of the heart's action may be divided into a period of motion and one of rest; the former is subdivided into three distinct stages or periods indicated in the diagram (fig. 13). Now, it is important to observe that when the heart's pulsations follow one another with great rapidity, the period of rest is reduced to a minimum; and when, on the contrary, the heart's action is slow, the period of rest is much lengthened, in proportion to the period of motion; the consequence of this is, that the normal sounds which occur during the contraction and dilatation of the ventricles change their relation to one another according as the pulsations are in rapid succession or the contrary. In the former case the interval, between the second and first sound (which includes the period of rest, and the contraction of the auricles) is very short; in the latter, it is very long. Hence the altered relation which is indicated to the eye in fig. 14, and which is very embarrassing to the beginner.

The larger circumference of each successive circle indicates the lengthening of the pause; and, accordingly, you have the interval between the *first* and *second* sounds occupying a less and less arc of the circle, as the heart's action gets slower, while the interval between the *second* and *first* sounds is correspondingly lengthened. In the first and smallest circle, indicating the most rapid action, the two intervals are nearly

alike, and each occupies about one-half the circumference; in the last or largest circle (indicating very slow action), the interval between the *second* and *first* sounds is four times as long as that between the first and second. Hence it is that, when the heart is acting rapidly, it is difficult to distinguish the *first* sound from the *second*, and *vice versâ;* while with the slowly acting heart this difficulty does not occur. Attention to these varieties—physiological varieties they may be called—in the rhythm of the sounds is of very great importance in determining the attributes of a cardiac murmur; for the first step in the inquiry is to determine which is the second sound and which is the first; and this, as I have said, is sometimes not quite an easy matter. Generally speaking, and in all cases when the action is slow and regular, there is no difficulty; you have only to remember that the longer interval is between the *second* and *first* sounds, and the shorter interval between the *first* and *second;* but when the action is rapid or irregular, and when the first sound is indistinct at the apex, or cannot be identified with the apex beat, and also when the second sound is indistinct, or when it is audible only at the base, the first sound being audible only at the apex, as sometimes happens, the difficulty of recognition of the two sounds is very considerable.

Fig. 14.



LESSON X.

Methods of Cardiac Physical Examination.

THE methods of physical examination of the heart include *inspection*, *palpation*, *mensuration*, *percussion*, and *auscultation*.

By **Inspection** you note the exact point of the heart's impulse where it strikes the walls of the chest, and also whether there is any unusual pulsation, or any change in the form of the cardiac region. In a perfectly normal chest, the inframammary regions on either side are very nearly symmetrical; but in disease, the præcordial region may either be depressed, or on the contrary arched forward, and the intercostal spaces be widened. The most important information furnished by inspection relates to the cardiac impulse. This, in the majority of persons, is visible only in the fifth interspace, midway between the left nipple and the sternum, and its area does not exceed a square inch. You will generally find it most distinct in thin persons, while in fleshy individuals it is sometimes scarcely discernible; and you will also find that it may be modified by position, by distension of the subjacent stomach, and by the movements of respiration. Thus during a full inspiration you may note the impulse down in the epigastrium, and then during a forced expiration see it elevated and more diffused.

In *disease* you may find the impulse altered as respects its position, its area, or its force. Thus it is tilted upwards and outwards by enlargement of the left lobe of the liver; or it may be crowded over to the right side and downwards by simple pleuritic effusion or emphysema, so that I have seen it

beating even externally to the right nipple; it may also be forced upwards by pericardial effusion, or downwards and to the left in cardiac hypertrophy. Not unfrequently in cases of pericardial agglutination, or dilatation of the ventricles, an undulating impulse will be visible.

Palpation.—This is of much greater clinical importance than inspection. By it we determine the force of the cardiac pulsation; the frequency or slowness of the heart's action; and the regularity or irregularity of its movements. By it also we detect the presence of the friction fremitus, and what is termed the "*purring tremor.*"

The force of the cardiac impulse may be diminished or increased.

Diminution of the Impulse may depend either upon feebleness of the action of the heart in consequence of degeneration of its tissues, or upon prostration of the whole system as in collapse; or upon the apex of the organ being prevented from impinging against the walls of the chest with its customary force, as happens in disease of the lungs and pericardium.

Increase in the Impulse.—In the majority of instances, this is caused by hypertrophy of the walls of the left ventricle, and a slow progressive impulse can be produced by no other cause. In such cases the area over which the cardiac impulse can be felt is much increased. In the early stage of endocarditis, and of pericarditis, and in palpitations from functional disorders, the impulse is slightly increased.

Change in the Situation of the Impulse.—A change in the situation of the cardiac impulse may either occur as the result of hypertrophy of the heart, or of its displacement from disease of the lungs or pleura.

The frequency and regularity of the heart's action is of great importance in the diagnosis of cardiac disease; and it can often be most accurately determined by palpation.

The **Purring Thrill** (the "*frémissement cataire*" of Laennec) is a peculiar vibratory sensation perceptible on making pressure at the præcordium. In some the pressure need be but slight, while in others it should be firm. It may also be communicated by the large arteries, etc.

Percussion.—By percussion we aim to determine the exact outline of the heart itself, and of its investing membrane, to determine whether it exceeds its normal area; and to do this well, you will find both care and practice requisite. In performing cardiac percussion, the patient should be in a recumbent posture, and you need tap but lightly over the part where the heart is not covered by lung tissue, to obtain a flat sound. Where, however, the lungs overlap the organ, you must percuss more forcibly to elicit cardiac dulness, and this sound will of necessity have more or less of a pulmonary quality. We have, therefore, two degrees of cardiac dulness,—the superficial and the deep-seated. In *health* the area of the superficial dulness does not exceed two inches in any direction; it is triangular in form, with the apex immediately below the junction of the left third rib with the sternum, while the base is on a line with the cartilage of the sixth rib. The area of the deep-seated dulness in health extends transversely from the left nipple to half an inch to the right of the sternum, and vertically from the second to the sixth interspace.

The area of the heart's superficial dulness may be increased or diminished; increased, when the ventricles are hypertrophied, or when their cavities are dilated, and also when the pericardium contains fluid; diminished, at the end of a full inspiration, and in pulmonary emphysema from its inducing a general distension of the air cells. The area of the deep-seated dulness is increased by enlargement of the heart, whether this be due to ventricular dilatation, or to hypertrophy of its muscular parietes; and it is *apparently* increased by consolidation of the anterior border of the investing lung,

and also by fluid in the left pleural cavity. We are also often much assisted in determining the limits of the deep-seated dulness in certain cases by *auscultatory* percussion.

Auscultation.—For reasons already stated I prefer mediate to immediate auscultation in examining the heart, and in practising it you will find of service the following simple rules:

1. The posture of the patient should be recumbent when you begin your examination. Then, having carefully elicited all the auscultatory symptoms which this posture affords, repeat your examination with him sitting or standing, and note whether any variations in the sounds heard have occurred from the change in his position.

2. You should first listen to the heart sounds while the patient is breathing naturally; having done so, then direct him to hold his breath for a moment; and finally tell him to take three or four forced inspirations. These various means are often all requisite before we can correctly discriminate between the different signs in cardiac auscultation.

3. You should not confine your examination to the præcordial region alone, but should explore the whole thoracic cavity and endeavor to localize the points at which the heart sounds, both normal and abnormal, are heard with the greatest intensity. To this end proceed in your examination from below upwards, and from left to right.

As in the case of pulmonary auscultation, so here, the normal characters must be the starting-point or standard by which every system in cardiac auscultation is to be compared. You cannot, therefore, pay too much attention towards acquiring a familiarity with the elements of the heart sounds in health. These elements are as follows: When the ear or stethoscope is applied to the præcordial region, two successive sounds are heard, followed by an interval of silence, which therefore does not intervene between the first and second, but between the second and first. The first sound is softer, lower

in pitch, and more prolonged than the second; as has already been shown in fig. 13, it coincides with the systole of the ventricles and with the apex beat; it immediately precedes the radial pulse, and has its maximum of intensity in the fifth interspace, a little to the right of the left nipple. The second sound is sharper, or higher pitched, shorter and more superficial than the first. It is synchronous with the diastole of the ventricles, occurs after the pulsation of the arteries, and has its maximum of intensity at the junction of the third left rib with the sternum.

The period of silence immediately following the second sound varies in length with the rapidity of the heart's action. The order and duration of the respective periods of the sounds, and the silence, you will be able to appreciate best by referring to diagrams Nos. 13 and 14.

The *intensity* of the heart sounds varies in health according to the force of the heart's action, or according to the conformation of the chest, or according to individual idiosyncrasies. These sounds are less intense in fleshy or muscular persons with capacious chests, than in thin, narrow-chested, and nervous individuals.

The *extent* of surface over which the heart sounds are heard varies with the adaptation of the adjacent organs for transmitting sounds. Generally speaking, the sounds produced on the right side of the heart are more audible on the right side of the præcordial region; while those produced on the left are more pronounced on their corresponding side.

Mechanism of the Heart Sounds.—There has been much difference of opinion on this subject. My own opinion is this: that the *first* sound is produced by the closure of the mitral and tricuspid valves; also that it has in addition elements in its production which are not valvular; namely, sound from the impulse of the heart's apex against the thoracic walls, from the contraction of the ventricles, and, lastly, from the

friction of the blood against the walls of the ventricles, and against the ventricular surface of the valves. Some eminent authorities, however, regard the closure of the above-mentioned valves as the one and only cause of this sound. As to the *second* sound, all are agreed to its proceeding from the sudden closure and tension of the aortic and pulmonary valves, by the reflux of the blood on them during the diastole of the heart.

Pathological Modifications of the Normal Sounds.—In disease, the normal sounds of the heart present various definite alterations as regards their intensity, quality, pitch, seat, and rhythm; and they may also be accompanied, preceded, or followed by adventitious sounds or murmurs.

An *increase of intensity* may be noted in cases of hypertrophy and dilatation of the ventricles; in cases also of nervous irritability of the heart, or where there is consolidation of the adjacent lung tissue. A diminution in intensity may be found depending either upon dilatation of the ventricles without hypertrophy of their walls; or upon fatty degeneration of the muscular tissue of the heart; or on softening of the same, as in typhus and typhoid fevers; or it may be owing to a muffling of the heart sounds by pericardial effusion, or by emphysematous distension of the anterior border of the lung.

Alterations in Quality and Pitch.—The heart sounds in disease may become dull and low-pitched, or sharp and high-pitched. The first sound is dull, muffled, and low-pitched, when hypertrophy is conjoined with a thickened condition of the auriculo-ventricular valves. On the other hand, where the ventricular walls are thin, and the valves natural, the first sound becomes sharp and clicking in character, and the pitch is raised. The second sound is rendered dull and low-pitched, by diminished elasticity of the arterial walls, and by thickening of the aortic valves, without regurgitation. Sometimes the

heart sounds have a metallic or tinkling quality which depends either upon an irritable action of the heart, or on a gaseous distension of the stomach.

Alterations in Seat.—This refers to the points of the maximum intensity of the respective sounds, which may be displaced, 1st, upwards by certain changes in the abdominal viscera; or, 2d, downwards, by tumors in the mediastinum, and by hypertrophy with dilatation of the auricles; and lastly laterally, by the accumulation of air or fluid in the pleural cavities. Malformations of the thorax may likewise displace them in different directions.

Alterations in Rhythm.—It not unfrequently happens that a distinct intermission occurs in the heart's action. After a certain number of regular beats, a sudden pause or silence occurs; the heart's action seems to be suspended for an instant, and then to go on regularly. This intermission is often observed in individuals who are in perfect health. It also occurs in diseased states of the valves or orifices of the heart. It is difficult to explain its cause, and it has no precise pathological significance.

Irregularity in the Heart Sounds, however, constitutes another and different alteration in rhythm. The sounds become confused and tumultuous; they are alternately loud and feeble; at one time slow for two or three beats, and then they follow each other in rapid succession. When the irregularity is permanent, it is almost positive evidence of organic disease of the heart; the most frequent form being contraction of the mitral valves.

One or both of the heart sounds, as well as the period of rest, may be prolonged or shortened. In hypertrophy of the ventricular walls the first sound is prolonged. In dilatation of the cavities of the ventricles it is shortened. The first sound is also prolonged when the two surfaces of the pericardium are adherent. An obstacle to the flow of the blood into

the ventricles prolongs the period of repose. Another alteration in the rhythm of the heart sounds is named *reduplication*. Each systolic sound may be repeated twice for one diastolic; or the diastolic may occur twice for one systolic. Sometimes only one sound is audible.

The essential cause of the various reduplications seems to be a want of synchronism between the action of the two sides of the heart. It may occur at all ages, and is as common with one sound as with the other. Intermittence is an almost constant character of reduplication, the sound being doubled with some beats of the heart, and not with others. This intermittence in some instances is undoubtedly connected with the movements of respiration; in laborious respiration the first sound may be doubled at the end of inspiration and the beginning of expiration; and the second sound at the end of expiration and the beginning of inspiration. *Clinically*, it is important to distinguish true doubling of the sounds from those false reduplications which are in reality compounded of a sound and a murmur.

LESSON XI.

Abnormal Sounds of the Heart.

Pericardial and Endocardial Murmurs.

THE term *murmurs* has been applied to those adventitious sounds which accompany or replace the normal sounds of the heart, and which are not heard in health. Their seat may be either within the heart, at the orifices of the ventricles, when they are called endocardial or valvular murmurs; or they may be external and in the pericardium, when they are termed exocardial or pericardial friction sounds.

Pericardial Friction Sounds.—The pericardium is a serous membrane investing the heart, as the pleura invests the adjacent lung; and therefore when it is inflamed we have exactly analogous results with those which we described as appertaining to pleurisy; namely, first dryness, and then plastic and serous effusion, with the different friction sounds which are caused by the rubbing of the roughened surfaces of the opposed membrane upon one another during the movements of the heart. This similarity sometimes makes it a nice point in diagnosis to distinguish a pericarditis from a pleuritis, but the determining consideration will be, that when it appertains to the heart, it is limited to the præcordial space, or at least that it is synchronous with the cardiac, and not with the respiratory *movements.*

The different forms of the pericardial friction sounds have been named, like those in pleuritis, grazing, rubbing, creaking, rasping, etc. Clinical experience, however, does not always

show any definite connection between the state of the serous surface and the quality of a friction sound. The grazing variety appertains to the initial stage of the inflammation; the other varieties occur after the plastic effusion, and while it is undergoing organization. These sounds vary in intensity, from the slight rustling which can be heard only by close attention, to a loud rasping sound audible before your ear is applied to the chest. As a rule, they become more distinct during expiration than inspiration, and while the patient is sitting, rather than while recumbent, owing to the greater approximation of the pericardium to the chest wall during these states.

Pericardial friction sounds may be single or double, that is, accompanying both the systolic and the diastolic movements, or either one singly. They may accompany the valvular sounds, or be independent of them; and they usually convey the impression of being superficial in comparison with the endocardial murmurs. They are generally restricted to the pericardial space, the point of maximum intensity being usually at the junction of the fourth rib with the sternum; and they do not often last long, disappearing frequently after a few hours, or at most in a few days.

A pericardial murmur is distinguished from an endocardial by its rubbing quality, by its superficial character, and by its *not being transmitted beyond the limits of the heart*, either along the arteries or round the left side to the back. It may also be distinguished from a valvular murmur by its intensity varying with a change in the position of the patient, and by its independence of the heart sounds.

Endocardial or Valvular Murmurs.

In endocardial murmurs, the elements of quality and intensity hold but a subordinate place as regards either diagnosis or prognosis. The same murmur may be at different times,

blowing, grating, rubbing, or musical, in character, without its significance altering in the least through all these changes in its quality. "The mere fact that a murmur exists, and has a certain acoustic quality, tells very little as regards the true character of a case."* Practically speaking, endocardial murmurs may be regarded as "audible announcements" that something has occurred to roughen the surfaces of the endocardium, or to constrict the orifices of the heart, or to render the valves insufficient, so that they allow the blood to regurgitate, or to diminish the elasticity of the great vessels, or finally, that some change has taken place in the natural constituents of the blood itself.

Having ascertained the existence of a cardiac murmur, the first question then is, What is its pathological significance, or in what way has it been produced? To determine this, it is necessary to observe particularly two points: 1st, The *rhythm*; and, 2d, The *seat* of the murmur.

The Rhythm of a Murmur.—Under this head we ascertain the relation of a murmur to the different physiological acts which constitute a complete cardiac pulsation. We define the murmur as occurring during either portion of the heart's action, or during the rest which intervenes between the periods of activity. To do this, we note carefully its relation to the normal sounds, to the impulse, and to all the other appreciable phenomena which attend upon the heart's action. By referring to fig. 13, you have before you the whole audible and tangible phenomena of the heart's action, and their relation to the physiological movements which cause them.

Evidently the first step is to determine which is the first, and which is the second sound of the heart. When the

* In treating of the significance of the cardiac murmur, I have followed Dr. Gairdner's method in preference to any other with which I am acquainted, and in some instances have adopted his phraseology.

heart's action is slow and regular, this is quite an easy matter; but when the heart is acting rapidly, it is always difficult, and sometimes impossible, to distinguish the one sound from the other. It is important, therefore, not only to know theoretically all the appreciable phenomena of the physiological action of the heart, but it should be a familiar tangible knowledge.

Having identified the two sounds, and traced their relation

Fig. 15.

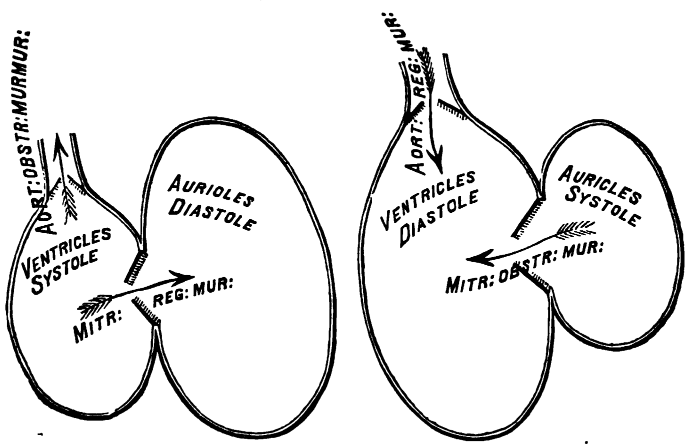


Diagram illustrating the Mode of Production of Cardiac Murmurs in the Left Heart, and the Condition of the Valves and Cavities during their Production. By substituting the words Tricuspid and Pulmonary, for Mitral and Aortic, the Diagram will similarly illustrate Murmurs Occurring in the Right Heart.

to the apex beat, and the radial pulse, the *rhythm* of a murmur is readily determined; for all *valvular* murmurs either *precede, or take the place of, or immediately follow* one of the heart sounds.

First. A murmur may precede and run up to the first sound, ending at the moment of the sound, and with the apex beat. In this case, as shown by fig. 15, the murmur is simultaneous with the contraction of the auricles, and is either a *mitral* or *tricuspid obstructive murmur,* as it is produced on the right or left side of the heart, while the blood is passing from the

auricles to the ventricles. Such murmurs, therefore, depend either upon contraction of the mitral or tricuspid orifices, or upon deposits on the auricular surface of these valves, causing obstruction to the flow of blood out of the auricle during its contraction.

Second. A murmur may take the place of, or follow the first sound, ending somewhere between the first and second sounds. In this case the murmur is coincident with the contraction and emptying of the ventricles, and must be caused, as is shown in fig. 15, either by obstruction to the current of blood as it flows outwards from the ventricles, in its natural direction into the aorta and pulmonary artery; or backwards by regurgitation, through the mitral or tricuspid valves. If it occur on the left side of the heart, it is either an *aortic obstructive* or a *mitral regurgitant* murmur; if it occur on the right side of the heart, it is either a *pulmonic obstructive*, or a *tricuspid regurgitant* murmur.

Third. A murmur may take the place of, or follow the *second* sound, ending somewhere during the interval between the second and first sounds; in some instances it may be prolonged through the whole period of rest. This murmur is simultaneous with the dilatation of the ventricles (fig. 15), and is produced by regurgitation of blood through the aortic or pulmonary valves, and is either an *aortic regurgitant* or a *pulmonic regurgitant* murmur.

We may have, therefore, eight distinct endocardial murmurs, four systolic, and four diastolic. Not unfrequently we find in practice, various combinations of these different murmurs in the same case. For instance, it is not unusual to have a mitral obstructive and mitral regurgitant murmur combined, so as to appear to constitute one murmur; the first sound of the heart will, however, enable you to separate the two murmurs. In like manner, an aortic obstructive and regurgitant murmur are frequently combined; here also the sound inter-

venes, and makes the rhythm quite plain. The greatest difficulty is when the normal sound is merged into the murmur, as is often the case when the mitral obstructive and regurgitant are combined.

The precise pathological significance of endocardial murmurs is apparent from the following table:

TABLE OF CARDIAC MURMURS.*

Periods of Heart's Action.	*Seat of Murmur.*		*Cause of Murmur.*
Systolic.	Left side of heart.	Aortic	Obstruction to the onward flow of blood through the aortic orifice, or through the aorta.
		Mitral	Regurgitation of blood through the mitral valve into the left auricle.
	Right side of heart.	Pulmonary	Obstruction to the onward flow of blood through pulmonary orifice, or through pulmonary artery.
		Tricuspid	Regurgitation of blood through the tricuspid orifice into right auricle.
Diastolic.	Left side of heart.	Aortic	Regurgitation of blood through the aortic orifice into left ventricle.
		Mitral	Obstruction to the flow of blood from left auricle to left ventricle.
	Right side of heart.	Pulmonary	Regurgitation of blood through the pulmonary orifice into right ventricle.
		Tricuspid	Obstruction to flow of blood from right auricle into right ventricle.

Although eight distinct valvular murmurs may occur in the heart; those on the right side are of such rare occurrence, that they are of little clinical importance. If a murmur is heard with the first sound of the heart, it is almost certainly *aortic obstructive*, or *mitral regurgitant;* if with the second sound, it is probably *aortic regurgitant.*

An obstructive mitral murmur is also of comparatively rare

*After Fuller.

occurrence; the force with which the blood passes from the auricle into the ventricle being ordinarily insufficient to excite sonorous vibrations.

Seat of Murmurs.—Having determined the rhythm of a murmur, the next step in the investigation is to find within as narrow limits as possible the place of its origin. The points at which endocardial murmurs are produced, being in the majority of cases one of the four valvular orifices, the first question to be settled under this head is, at which one of these valvular orifices it is produced?

At the commencement of the examination, every means should be taken to determine in each particular case the actual size and position of the heart, together with its relation to the thoracic walls and to the surrounding organs, the exact point of the apex beat, and the character of the impulse.

We must endeavor by careful stethoscopic examination to determine the exact seat, and the limits of diffusion of the murmur under observation. If the murmur is very loud or diffused, or if there are several murmurs present in the same case, it may give rise to some difficulty; but in the large majority of cases the observer will be able to fix on a few points, or a few restricted spaces, over which each murmur is heard, there being no murmur elsewhere; or, if not so, areas within which each murmur is heard with greatest intensity.

As there are four valvular orifices at which the majority of endocardial murmurs are produced, so there are four distinct areas to which murmurs arising at these orifices may be propagated.

The following rules will be found useful in recognizing these areas in actual practice:

I.—Area of Mitral Murmurs.—The maximum of intensity of mitral murmurs corresponds generally with the apex of the

left ventricle, represented in fig. 16 by the circle A. If it is produced by regurgitation of blood through the mitral orifice, its area of diffusion is to the left, on a line corresponding to the apex beat; the seat of diffusion in front corresponds very nearly to the circle A, fig. 16; and it is also heard with very

Fig. 16.

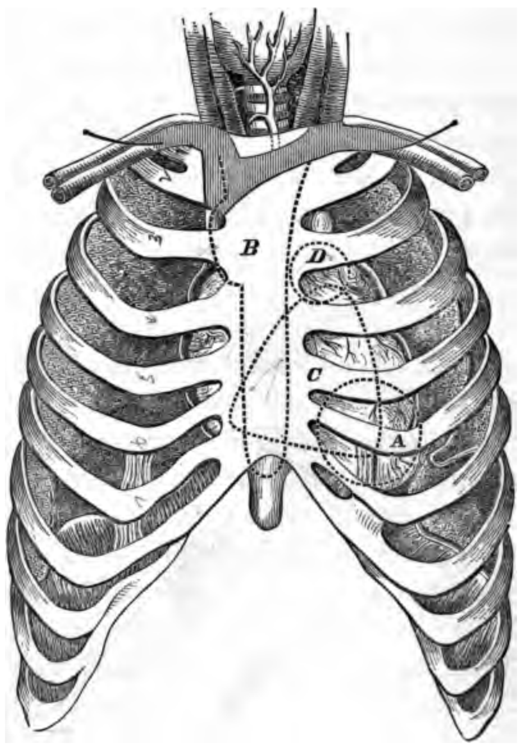


Diagram showing the Areas of Cardiac Murmurs. These several Areas correspond to the Different Spaces marked by the Dotted Lines, and a Capital Letter Designates each Area. A, the Area of Mitral Murmurs; B, of Aortic; C, of Tricuspid; and D, of Pulmonic.—GAIRDNER.

nearly the same intensity behind, between the lower border of the fifth, and upper border of the eighth vertebra, at the left of the spines as in front.

The area of diffusion of mitral obstructive murmurs is

usually limited to a circumscribed space (circle A) around the apex of the heart; in some instances these murmurs are heard with equal intensity over the whole superficial cardiac region. To the left of the apex beat they are always indistinct, and are *never heard behind.*

II.—Area of Tricuspid Murmurs.—The area of tricuspid murmurs corresponds to that portion of the right ventricle which is uncovered by lung tissue, indicated in the diagram by the triangular space C. This murmur is distinct and superficial in character, rarely audible above the third rib, and thus readily distinguished from the aortic and pulmonic murmurs. It is heard loudest near the xiphoid cartilage, and along the margins of the sixth and seventh costal cartilages. In cases of hypertrophy and dilatation of the right side of the heart, usually its point of maximum intensity is at the junction of the fourth rib with the sternum.

Area of Pulmonic Murmurs.—A murmur in the pulmonary artery, or at the pulmonary valves, is carried to the ear nearly over the seat of the valves, as indicated by the circle D in the diagram, fig. 16. Not unfrequently its maximum point of intensity is an inch, or even an inch and a half, lower down. It is usually very superficial, and consequently very distinct. It is limited in its diffusion, being inaudible at the apex, and also along the sternum; it is never heard in the neck, nor in the course of the great vessels.

Area of Aortic Murmurs.—The law of diffusion of aortic murmurs is not easily explained; not only are they heard with great intensity over the base of the heart, at the junction of the third rib with the sternum on the left side, but frequently, and not less distinctly, along the whole length of the sternum, as is indicated by the dotted lines along the edge of the sternum, in the irregular space B, fig. 16. Sometimes they are absolutely louder close to the xiphoid cartilage than at any other point. An aortic murmur is distinguished from

all other cardiac murmurs by being propagated into the arteries of the neck. It is the most widely diffused of all cardiac murmurs, and can sometimes be traced to a very great distance from the heart, and may be heard behind near the lower angle of the scapula.

To complete the diagnosis of endocardial murmurs it is necessary to consider their rhythm in connection with their area.

First. A murmur which immediately precedes the first sound of the heart, may be either a mitral or tricuspid obstructive murmur, and is produced by obstruction to the current of blood as it passes from the auricles into the ventricles. If it is a mitral obstructive murmur, its maximum of intensity will correspond to the circle A, fig. 16; if, on the contrary, it is a tricuspid obstructive murmur, its maximum of intensity will be within the triangle C.

Second. Murmurs accompanying or following the first sound, and occurring between the first and second sound, may be produced, either in the auriculo-ventricular, or in the arterial orifices, and they have four distinct solutions.

a. If a murmur following the first sound has its origin at the mitral orifice, it is a *mitral regurgitant murmur*, and is produced by regurgitation of the blood backwards from the left ventricle into the left auricle. Its maximum of intensity in front will correspond to the circle A, fig. 16; and it will be heard behind.

b. If its origin is at the tricuspid orifice, it is a *tricuspid regurgitant murmur*, and is produced by regurgitation of the blood backwards from the right ventricle into the right auricle. Its maximum of intensity will correspond to the triangle C, fig. 16.

c. If its origin is at the aortic orifice, it is an *aortic obstructive murmur*, and is produced by obstruction to the current of blood as it passes in its natural course, from the left ventricle

into the aorta. Its maximum of intensity will correspond to the irregular space B, fig. 16.

d. If its origin is at the pulmonic orifice, it is a *pulmonic obstructive murmur*, and is produced by obstruction to the current of blood as it passes from the right ventricle into the pulmonary artery. Its maximum of intensity will correspond to the circle D, fig. 16.

Again, murmurs accompanying or following the second sound of the heart may be produced at the aortic or pulmonic orifice, and in either case coincide with the filling of the ventricles.

a. If a murmur accompanying or following the second sound has its origin at the aortic orifice, it is an *aortic regurgitant murmur*, and is produced by the regurgitation of the blood from the aorta *backwards* into the left ventricle. Its maximum of intensity corresponds to the space B, fig. 16.

b. If a murmur following the second sound has its origin at the pulmonic orifice, it is a *pulmonic regurgitant murmur*, and is produced by the regurgitation of blood from the pulmonary artery into the right ventricle. Its maximum of intensity corresponds to the space D, fig. 16.

One, two, three, and even four of the murmurs we have been considering, may occur in combination in the same case. The most frequent combinations are the aortic obstructive and regurgitant heard over the area B, fig. 16; next, the mitral obstructive and regurgitant heard over the area A; then we have various combinations of these, the aortic and mitral valves being both diseased.

Murmurs occurring on the right side of the heart are comparatively of rare occurrence; the tricuspid regurgitant being the only one that is of practical importance.

Anæmic and Functional Murmurs are soft and blowing in character, are always systolic, and almost always aortic. As regards their area, they are generally diffused, not only over

the base of the heart, but along the course of the aorta and the vessels of the neck.

An anæmic is distinguished from an organic murmur by its blowing character; by always accompanying the first sound of the heart; by being audible in several of the arteries at the same time; by not being constantly present, occasionally disappearing when the circulation is tranquil, and returning when it is accelerated; by the presence of the general signs of anæmia; by the absence of the physical or general signs of organic disease of the heart; by entirely disappearing under treatment calculated to relieve the anæmic state of the system.

Venous Murmurs all come under the class of inorganic murmurs. The so-called venous hum is a continuous humming sound, having frequently a musical intonation. It is best heard over the jugular just above the clavicles, the patient being in a sitting or standing position. It is characteristic of anæmia, and is almost always associated with an arterial anæmic murmur.

Before leaving the subject of cardiac murmurs, I will give you some rules in relation to them, copied from the unpublished writings of the late Dr. Cammann; they are the result of long and careful observation, and although they differ in some respects from the teachings of many auscultators, I have found them of great service in diagnosis.

Cardiac Murmurs.

Aortic Obstructive Systolic.

"When it reaches the apex it is with diminished intensity.

"When heard behind, it is most distinct at left of third and fourth vertebræ, close to their spines, and frequently extends downwards along the spine in the course of the aorta, but with diminished intensity. Although the heart only ex-

tends as high as the fifth vertebra, the murmur is heard above that point, because here the aorta approaches the surface.

Aortic Regurgitant Diastolic.

"The intensity of the murmur from valve to *right* of apex may or may not increase downwards, depending on the proximity of heart to parietes, the position of lungs, etc.; it may decrease downwards, however, from emphysema, supine recumbency, etc., or may perchance be loudest at apex; depending on proximity of heart to the parietes, position of the parts, condition of the mitral valve, etc.

"Generally it is not heard behind, but *may*, towards inner side of lower angle of scapula, in thin subjects especially, be heard in the same place where is heard the non-mitral regurgitant; this non-mitral regurgitant being the mitral regurgitant of Bellingham and others.

"It is sometimes conveyed to left axilla.

"The patient when recumbent may sometimes hear it himself."

Mitral Regurgitant Systolic.

"To indicate regurgitation, the murmur must be heard between lower border of fifth, and upper border of eighth vertebra at left of spine, provided the transmission of the sound be not interfered with by thickness of integuments, or other conditions of the parts.

"When not heard in this place, but in "left axilla and in the region of the left scapula," regurgitation is not indicated; or, in other words, it is a non-regurgitant murmur, contrary to the teaching of Bellingham and others.

"If there be a systolic murmur with a maximum of intensity between fifth and eighth vertebræ, at left of spine, it indicates regurgitation.

"An aneurismal murmur, however, may be heard within the said limits, but it follows the aorta downwards, gradually decreasing in intensity, without the *abrupt* termination of the regurgitant murmur.

"We occasionally meet with mitral regurgitant murmur posteriorly, yet absent anteriorly.

"The mitral regurgitant murmur may sometimes cease entirely, from such a change in the structural condition of the diseased valve, or from such contraction of the auriculo-ventricular opening, as will allow the valve to close so as to prevent regurgitation, there being actually in this case increased mechanical obstruction.

"The following complication may exist; viz., aortic obstructive systolic, with aortic regurgitant diastolic extending *to* the apex, with the mitral regurgitant behind, without a corresponding murmur in front.

"All these murmurs are not unfrequently heard to right of apex, and even over the whole chest.

"A mitral diastolic murmur we have not heard. If ever present, as stated by distinguished auscultators, it must depend upon physical condition external to the heart. Thus, pleuritic effusions, or the like, in certain positions, by pressing suddenly and strongly upon the left auricle, may possibly force the blood with sufficient rapidity through an obstructed auriculo-ventricular orifice to cause an abnormal sound.

"Some auscultators, however, deny the possibility of the occurrence of this murmur under any contingency whatever."

Ventricular Murmurs.

Not unfrequently during the active progress of endocarditis, as well as after the acute stage is passed, a murmur is heard taking the place of, or following the first sound of the heart. These murmurs are not conveyed to the left of the apex, nor heard along the course of the aorta. They are undoubtedly

produced within the cavity of the left ventricle, either by the roughening of the cordæ tendinum, or the ventricular surface of the mitral valves, or perhaps by an abnormal direction to the current of blood as it passes through the ventricle. They may properly be called *ventricular murmurs*, and may be distinguished from other murmurs by the time of their occurrence, and by their limited area of diffusion.

Sounds produced by the Action of the Heart which are neither Endocardial nor Pericardial.

Sounds sometimes are heard in the precordial region produced by the action of the heart on the lungs. These sounds are mostly systolic and inspiratory; they usually cease to be produced when the respiratory movements are arrested. A *blowing sound* resembling a cardiac murmur may be produced in the lung tissue covering the heart, during a cardiac systole. A pulmonary cavity near enough to the heart to be influenced by it sometimes affords a loud systolic murmur. Sounds resembling rales may be produced by the movements of the heart upon the bronchial tubes. Friction sounds generated in the pleura, of a crackling, rasping character, synchronous with the cardiac systole, are not unfrequently heard. A friction sound heard behind and along the edge of the sternum from the second to the sixth rib is always pericardial; but when a friction sound is heard at other parts of the precordia, the diagnosis is often difficult. Pleuritic friction sound usually ceases when the breath is held, but this is not always the case.

LESSON XII.

Synopsis of the Physical Signs of Pericarditis.—Hypertrophy, Dilatation, and Fatty Degeneration of Heart, and Aneurisms of Thoracic Aorta.

Synopsis of the Physical Signs of Pericarditis.

The physical signs of pericarditis vary with the different stages of the disease. In the early period of the attack, the only sign furnished by inspection and palpation is an irritable and forcible action of the heart, and there is no change in the area of the præcordial dulness on percussion. For some time the only characteristic sign of its presence is the pericardial friction sound. After a time, as the inflammation progresses, effusions take place into the pericardial sac, and we have the second stage, or stage of effusion.

Inspection now discloses a prominence, or arching forward, of the præcordial region, and a diminution in the respiratory movements of the left side.

Palpation shows the point of the apex beat to be raised and carried to the left of its normal position; or, if the quantity of the effusion be large, it is entirely suppressed. Sometimes, in extensive pericardial effusions, an undulatory impulse is felt. The position of the impulse will often be noticed to change with a change in the position of the patient. If the cardiac impulse is entirely absent when the patient is in the recumbent posture, and becomes perceptible when he is placed in a sitting posture, you have strong presumptive evidence in favor

of pericardial effusion. Sometimes when the pericardium is very greatly distended, the diaphragm is depressed, and bulging can be detected in the epigastrium.

Percussion.—The area of the precordial dulness is enlarged vertically and laterally. At the beginning the dulness is principally increased upwards; but any considerable amount of effusion is denoted by an increase in the width of the area of dulness at the lower portion of the precordial region. As the effusion increases, the shape of the enlarged area corresponds to the pyramidal form of the pericardial sac, as is represented in fig. 17.

Fig. 17.

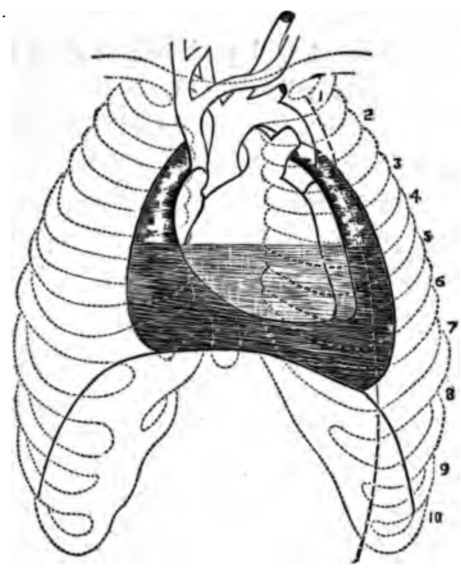


Diagram showing the Pericardial Sac partially filled with Fluid, and Plastic Exudation upon the two Surfaces of the Pericardium above the level of the fluid.

When the pericardial sac is distended with fluid the dulness will reach as high as the first rib; not unfrequently it reaches an inch or more to the right of the sternum, and occasionally it extends from nipple to nipple.

Auscultation.—The friction sound of the plastic stage becomes more and more indistinct until it ceases altogether. The heart sounds become feeble or are entirely lost, and the respiratory murmur and the vocal resonance are absent over the area of precordial dulness.

When recovery takes place and the fluid effusion is absorbed, the bulging of the precordial region, which was present in the stage of effusion, subsides, and the area of dulness on percussion decreases; the friction sound reappears; the heart sounds become distinct; the apex resumes its normal position; the impulse regains its natural force, and the respiratory and vocal sounds are again heard over the space formerly occupied by the distended pericardium.

Adhesion of the heart and pericardium does not admit of diagnosis, unless firm adhesions have formed between the external surface of the pericardium and the adjacent tissues, which, afterwards, cause dilatation and hypertrophy of the heart, accompanied by recession of the apex beat, retraction of the epigastrium, and diminished motion of the pericardial portion of the diaphram during a full inspiration.

Synopsis of the Physical Signs of Cardiac Hypertrophy.

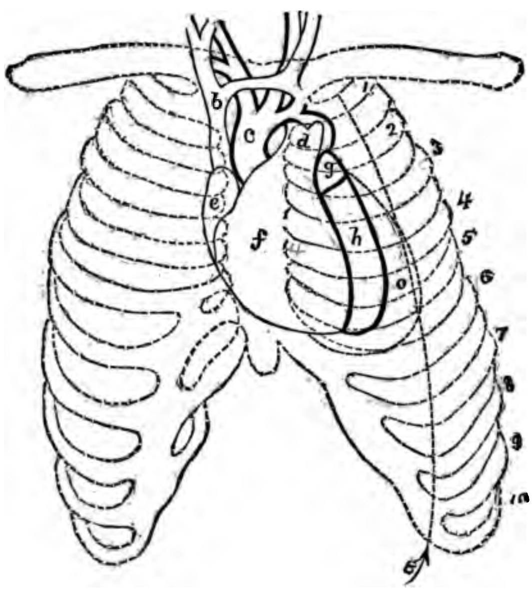
The physical signs of hypertrophy of the heart vary with the seat and extent of the hypertrophy. When the hypertrophy is general, *inspection* shows the action of the heart to be regular and the visible impulse to be increased in extent and in force. In children there is a visible prominence of the precordial region.

Palpation.—The area greatly exceeds that within which the normal apex beat is felt, and the impulse has a heaving, lifting character. When the right ventricle is hypertrophied, the conducted epigastric impulse is strong. When the left ventricle is hypertrophied, the apex beat reaches farther to the left than

natural, sometimes three inches below and three or four inches to the left of the normal position.

Percussion.—The area of both the superficial and deep-seated dulness increases laterally and downwards. If the hypertrophy is confined to the left ventricle, the area of dulness on percussion may extend considerably beyond the left nipple, as is shown in fig. 18.

Fig. 18.



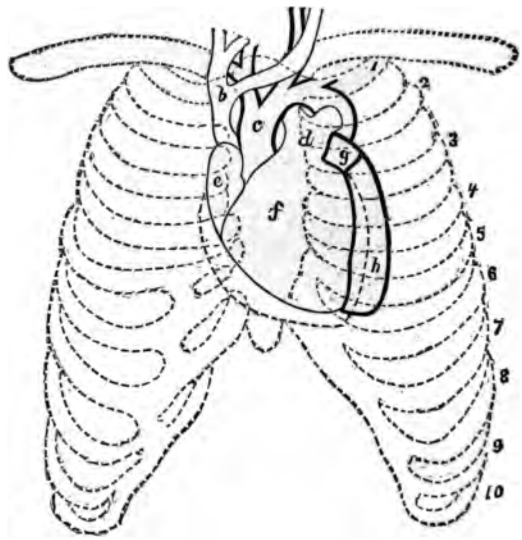
Hypertrophy of Left Ventricle. Heart in situ. a. The Mammary Line. b. Vena Cava Superior. c. Aorta. d. Bulb of Pulmonary Artery. e. Right Auricle. f. Right Ventricle. g. Left Auricle. h. Left Ventricle (normal circumference). o. The Hypertrophic Ventricle.—RINDFLEISCH.

If, on the other hand, the hypertrophy is confined to the right ventricle, the area of dulness may extend considerably to the right of the sternum, as is shown in fig 19.

Auscultation.—The first sound is dull, muffled and prolonged, and in some cases greatly increased in intensity. The second sound is also increased in intensity and more diffused

than in health, and there is a diminution or an entire absence of the respiratory murmur over the normal precordial region.

Fig. 19.



Hypertrophy of Right Ventricle. Heart in situ. Description as in the preceding figure. Contours of the Hypertrophic Right Ventricle are indicated by dots.—RINDFLEISCH.

When hypertrophy of the walls of the heart is attended with extensive dilatation of its cavities, the action of the heart is still regular, but the extent of the visible impulse is greatly increased, extending sometimes from the third intercostal space to the epigastrium. The apex beat may be felt as low as the ninth rib, and to the left of the nipple, and has a peculiar heaving character, so as sometimes to shake the bed of the patient.

The area of dulness may extend vertically from the third to the eighth rib, and laterally an inch to the right of the sternum and two or three inches to the left of the left nipple. Both sounds of the heart are prolonged, and are often audible over the whole chest, even to the right of the spine.

Dilatation of the Heart.

Inspection.—The visible area of the apex beat is greatly increased, but it is difficult to determine its point of maximum intensity. Sometimes there is an undulating motion over the whole precordial space.

Palpation.—By palpation you readily distinguish *dilatation* from *hypertrophy* by the feebleness of the cardiac impulse; and although it sometimes can be felt as far to the left as the axillary line, there is an entire absence of the lifting, forcible impulse which attends cardiac hypertrophy. Sometimes a purring thrill attends cardiac dilatation, especially when mitral regurgitation is present.

Percussion shows an increase in the area of precordial dulness in the horizontal axis of the heart, to the right when the right cavities are involved, and to the left when the left cavities are dilated. The shape of the dull space remains oval; this point is of importance in the diagnosis between cardiac dilatation and pericardial effusion.

Auscultation.—The sounds of a dilated heart are always short, abrupt and feeble; the second sound is often inaudible at the apex; the two sounds seem to be of equal duration. If endocardial murmurs have been present, as the dilatation becomes extreme, nothing is heard but a kind of swimming sound. The respiratory murmur is often feeble over the whole of the upper portion of the left lung.

Asystolism.

Asystolism is a term "employed to designate that remarkable group of symptoms which is characteristic of an enduring inability in the right ventricle to empty itself." * The physical signs are those of dilatation of the right side of the heart.

* Beau. Considerations générales sur les maladies du cœur.—*Arch. Gén. de Méd.*, 1853.

A short time before death additional signs occur, viz.: On palpation the cardiac impulse is feeble. On auscultation the heart sounds or any endocardial murmurs which may have been present become gradually more and more feeble, until nothing is heard except a humming sound. A tricuspid regurgitant murmur frequently develops when asystolism becomes urgent, but before the heart is so weakened as not to be able to produce a murmur. If the symptoms of asystolism are moderate, the murmur disappears.

Fatty Heart.

The physical signs of fatty degeneration of the heart in many respects are identical with those of cardiac dilatation. The area of the precordial dulness is normal; the impulse weak or imperceptible; the apex beat indistinct, and often invisible. The action of the heart is irregular; the first sound is short and feeble, and sometimes inaudible; the second sound prolonged and intensified.

LESSON XIII.

Aneurism of the Thoracic Aorta and Arteria Innominata. —Epigastric Pulsation.—Subclavian Murmurs.—Venous Pulsations and Murmurs.

Aneurisms of the Thoracic Aorta.

The thoracic aorta is affected by aneurism with varying degrees of frequency in the different parts of its course. According to Sibson, who has collected the statistics of 703 cases, 87 were at the commencement of the aorta in the sinuses of valsalva; 193 of the ascending arch, extra pericardial; 14 of the ascending and transverse arch; 12 of the transverse arch; 72 of the descending arch; and 71 of the descending aorta.

The physical methods employed in ascertaining the existence of aneurisms are *inspection, palpation, percussion,* and *auscultation.*

Inspection.—If the aneurism presses on the superior vena cava, you will observe the face, neck, and upper extremities to be swollen, livid, and occasionally œdematous; while the veins of these parts are turgid and varicose. But if the pressure is only on the innominata veins, these effects will be observed only on the corresponding side.

In some instances, there is, as it were, a thick fleshy collar surrounding the lower part of the neck, due to capillary turgescence. As you inspect the chest, a more or less extensive bulging may be observed at some point along the course of the aorta. The bulging may in some cases attain the size of a cocoa-nut, while in others it may be perceptible only on close examination. The non-existence of a tumor does not, however, prove that there is no aneurism, for if the aneurismal enlargement springs from the posterior wall of the arch, or from the descending arch or descending aorta, parts which are deeply seated, there may be no visible anterior bulging.

When the bulging portion is of large size, it is generally conical in shape, the surface being smooth, and the skin looking tense and glazed. In most cases you will observe a pulsation of the tumor synchronous with the heart's systole; where this occurs in the anterior portion of the chest, there seems to be two beats within the thorax at the same time. Sometimes you can only detect the pulsation by bringing the eye to a level with, and looking across the chest. If the aneurism is full of fibrin there may be no visible pulsation.

The *position* of the bulging affords a clue to the seat of the aneurism. *Aneurisms* of the *ascending* arch produce bulging to the right of the sternum, near the second costal cartilage; though when large it may extend into both mammary and infra-clavicular regions. Aneurism of the transverse arch causes protrusion of the upper part of the sternum. Aneurism of the descending arch protrudes to the left side of the sternum, though often, from the deep position of the artery in this part of its course, no tumor may be felt. Aneurism of the descending aorta shows itself on the left side of the spine, very rarely on the right.

Palpation.—By the application of the hand, you can appreciate better the size of the tumor, the nature of its contents (whether mostly fluid or solid), the condition of the walls as regards perforation of the sternum or ribs, and the character of the pulsation, which is usually that of a blow equally diffused in all directions. Besides the systolic impulse, a diastolic one sometimes occurs; generally it is slight, sometimes, however, it is quite forcible. In some cases you will obtain the impulse by pressing with one hand on the sternum, and the other on the back, when by ordinary palpation you would not detect it. Again, a thrill may be communicated to the hand, if the aneurism is at the upper portion of the arch; by pressing the fingers down behind the sternum a distinct impulse will be felt. You may also ascertain whether there is a

cessation or diminution of the expansive movement over the whole or part of one lung, and whether the vocal fremitus is lost over that side, and over the tumor.

The non-expansion and loss of vocal fremitus over the lung is due generally to the pressure of the aneurism on the air passages, or on the lung itself. When the aneurism presses on the carotid arteries, or when they are obstructed by coagula, a difference between the pulse of these arteries and their branches on the two sides will be noticed.

Percussion.—There will be dulness over the prominence, or over a circumscribed space, in the neighborhood of the course of the aorta, not, however, corresponding to the size of the aneurism, unless more forcible percussion be made than is safe. The resistance is increased in proportion to the amount of the fibrin in the sac. When the lung is condensed by inflammation, or collapsed by obstruction of the bronchus, there will be a greater area of dulness.

Auscultation.—Connected with an aneurism there are usually certain sounds or murmurs. In some cases neither are audible, owing either to the position of the aneurism, to the solidity of its contents, or to the nature of its orifice. These sounds resemble those of the heart, and are similarly called systolic and diastolic; they may be either equal to, or weaker or louder than, those of the heart: the systolic may exist alone, either or both sounds may be replaced by a murmur; for instance, there may be a systolic murmur only, or you may have both a systolic and a diastolic sound. The character of the murmur varies. It is usually short, abrupt, of low pitch, and as loud as or louder than the loudest heart murmur. It may be rasping, sawing, filing, etc. The diastolic murmur is rarer than the systolic, and is usually of a softer quality. Where the aneurism compresses a large bronchus, the respiratory murmur over the whole or a part of one side will be weak or suppressed; on the opposite side it

will be exaggerated. There is also loss of vocal resonance over the aneurism, and over the lung whose bronchus is obstructed. Where the lung is condensed from pressure, the breathing will be bronchial; where there is pressure over the trachea or bronchi, the breathing may be stridulous, and be rightly referred to a lower point of production than the larynx. Where there is irritation of the recurrent laryngeal nerve, this type of breathing may come from spasm of the glottis.

Differential Diagnosis.—You will find that the principal difficulties in diagnosis are between aneurisms and intra-thoracic tumors.

The latter are rare: they rarely pulsate, or, if they should, they will communicate to the hand a mere lifting pulsation; in some instances malignant tumors have, however, a true expansive impulse. Again, intra-thoracic tumors are not usually developed entirely in the tract of the aorta; their area of dulness is large, and the resistance communicated to the finger on percussion is usually great. As a rule there are no sounds or murmurs connected with them, though in some cases where a tumor is placed over the aorta, a murmur may occur. Tumors are more apt to produce persistent swelling, and œdema of the upper extremities, neck, and face. In a case of aneurism, this latter sign may become developed, and then disappear, owing to a change in the direction of the pressure. Tubercular consolidation of one apex, if associated with a murmur in the sub-clavian or pulmonary artery, might be mistaken for an aneurism. In the former we have the physical signs of phthisis. The murmur is heard in the course of the pulmonary or sub-clavian artery. The dulness is not circumscribed, and extends outwards, and not across the median line.

Pulsatile Empyema, it seems to me, could hardly be mistaken for aneurism, although such instances are on record,

for it does not occupy the position of an aneurism. Then you have the physical signs of effusion into the pleural sac, and it is attended by no sounds or murmurs.

Aneurism of the Arteria Innominata is distinguished from aneurism of the thoracic aorta, by the fact that the tumor appears early on the right of the sternum; as it increases, it protrudes the inner part of the clavicle, or extends upwards into the neck. Its pulsation is diminished or suspended by pressure on the carotid or subclavian artery, while an aneurism of the aorta will not be affected by such pressure.

Epigastric Pulsation may be produced by an aneurism of the abdominal aorta involving the cœliac axis, by tumors seated on the abdominal aorta, by displacement of the heart to the right, by regurgitation of blood into the hepatic veins consequent upon dilatation of the right side of the heart, and by pulsation of the abdominal aorta.

Not unfrequently the impulse of the apex beat, the heart being normal and in its normal position, is communicated to the epigastrium, and is mistaken for epigastric pulsation of a dilated heart.

The right ventricle, in such cases, will usually be found lower than its normal position, and may even beat against the zyphoid cartilage.

Subclavian Murmurs.—Not unfrequently just below the clavicles, especially on the left side, a systolic murmur is heard directly over or along the course of the subclavian artery. These murmurs resemble those produced by pressure on arteries. It is reasonable, therefore, to infer that they are produced in the same way—the exact anatomical condition, however, which causes them is still unsettled. Adhesions at the apex of the lung have been suggested; also pressure from pulmonary consolidation at the apex. One thing is certain, that they are more frequently met with in those persons who are phthisical than in others. They are often most intense during expiration.

I have known the presence of a subclavian murmur to be taken as an evidence of aneurism.

Veins.—A state of permanent turgescence or distension of the jugular veins as well as of the superficial veins of the upper part of the chest and neck, with or without pulsation, is frequently met with in the advanced stage of many forms of cardiac disease, in thoracic aneurism, and in any change in the thoracic organs which causes obstruction to the free passage of blood through the right side of the heart.

Permanent turgescence of the jugular veins is usually due to the distension of the right auricle; any obstruction, however, to the upper vena cava or innominata, such as compression, thrombosis, or stricture, will have the same effect. If the turgescence is temporary, a full inspiration will empty and collapse the distended veins, while a full expiration will increase their distension. On the other hand, if the turgescence is permanent, the condition of the veins is not affected by the respiratory acts.

Venous Pulsations may be *presystolic* or *systolic*. They are most marked in the jugular veins immediately above the clavicles.

Presystolic jugular pulsations are due to the contractions of the right auricle, but they can seldom be appreciated except when the intra-thoracic veins are distended. Sometimes in a perfectly healthy person when in a recumbent position, presystolic pulsation in the jugular veins can be seen.

Systolic jugular pulsation occurs with the systole of the ventricles and indicates regurgitation into the right auricle with the ventricular systole. Frudreich states that sudden collapse of the jugular veins occurs in some cases of pericardial adhesions. Pulsations in the carotid arteries often communicate systolic pulsations to the jugulars.

In auscultating the veins of the neck, besides the venous hum

already referred to in *Lesson XII.*, *presystolic*, *systolic*, and *diastolic* murmurs are sometimes heard over the jugulars.

Presystolic venous murmurs are only heard when the patient is in the recumbent posture, and are due to the passage of blood backwards through the mouth of the internal jugular.

Systolic venous murmurs are sometimes heard just above the clavicles, especially on the right side, in cases of tricuspid regurgitation.

Diastolic venous murmurs are only occasionally heard, and require for their production cardiac hypertrophy and dilatation with aneurism.

ABDOMEN.

LESSON XIV.

Introduction.—Topography of the Abdomen.—Contents of the Various Regions.—Abdominal Inspection, Palpation, Percussion, and Auscultation.—Diseased Conditions of the Peritoneum.

THERE are *difficulties* in the physical exploration of the abdomen which are not met with in similar examinations of the thorax.

First. Thoracic diseases involve in their diagnosis the examination of only one or two organs, or their appendages; while an abdominal affection may require for its diagnosis the examination of ten or twelve organs. Thus a tumor in the left side may be either an enlarged mesenteric gland, or it may be connected with the stomach, spleen, kidneys, ovaries, or uterus; or it may be a hernia, an abscess, an hydatid cyst, an aneurism, or, lastly, only a lump of fæces.

Second. The action of the thoracic organs is regular and rhythmical, and their contents unvarying; while the action of the abdominal viscera is often irregular and intermittent. An abdominal organ may also at one time be greatly distended with contents, and soon after be empty; when filled, its contents may be solid, fluid, or gaseous, or all these together. The lungs and heart contain respectively the same quantities of air and blood during every five minutes of ordinary life, but the stomach and bladder can never remain long in one condition, either full or empty.

Third. The abdominal organs are packed loosely in a cavity with loose walls. They therefore can be increased or de-

creased in size, so as to alter wholly their relations to their fellow organs. Thus the uterus, usually the smallest, will, in fulfilling its natural function, become much the largest of all, till it crowds even the thoracic organs; moreover, in disease, a single ovary may swell into a sac which will fill entirely the abdominal cavity. These constitute the chief difficulties in the physical examination of the abdomen, and they must always throw a certain degree of doubt upon all physical diagnosis directed to this part of the body.

To facilitate our examinations, and to render our inferences more certain, it is well to divide the abdomen into regions by passing imaginary planes through the body.

The divisions which have been proposed by different observers vary somewhat. The following, proposed by Dr. Bright, will, I think, be found most useful:

The abdomen may be divided into three general zones,—the epigastric, the umbilical, and the hypogastric.

The **Epigastric** zone is bounded above by the diaphragm, below by a horizontal plane passing through the anterior extremities of the tenth rib on either side. In a well-formed chest the cartilage of the tenth rib on either side offers a projection at its lower convex border, which can be felt without difficulty; a horizontal plane carried backwards through these points will pass between the bodies of the first and second lumbar vertebra. This zone is subdivided into the epigastric, and the right and left hypochondriac regions, which correspond to the spaces bounded by the false ribs.

The **Umbilical** zone is bounded above by the lower boundary of the epigastric, and below by a horizontal plane passing through the anterior and superior spinous processes of the ilia; this plane, if carried backwards, will pass between the second and third sacral spines.

The **Hypogastric** zone is bounded above by the lower boundary of the umbilical zone; below, in the centre, by the

upper margin of the pubes; on either side by Poupart's ligament. This zone occupies the whole cavity of the true pelvis. The umbilical and hypogastric zones have each three subdivisions made by two vertical planes, passing backwards through the spinous processes of the pubes and the points on the tenth ribs already alluded to. The subdivisions of the umbilical zone thus produced are termed the central or *umbilical*, and two lateral, or the *right* and *left lumbar*. The sub-

Fig. 20.

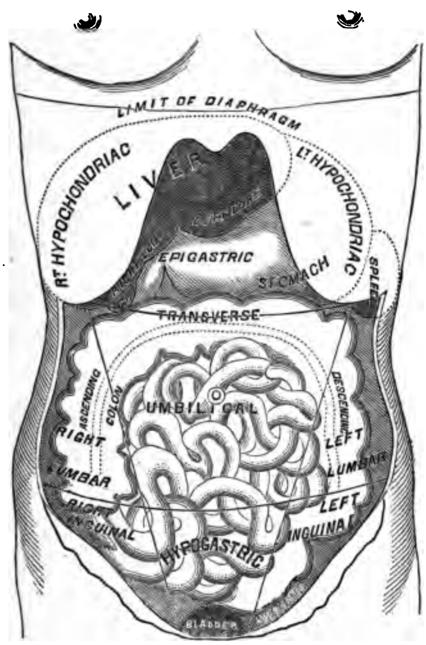


Diagram showing the different Regions of the Abdomen, and the Organs contained in each, which are visible on the removal of the Abdominal Walls.

divisions of the hypogastric thus produced consist of the middle or *pubic*, and the lateral or *right* and *left iliac*.

The organs contained in these regions in health are as follows:

The **Epigastric** region contains the whole of the left, and a

part of the right lobe of the liver; the gall bladder; the pyloric orifice of the stomach; the commencement of the duodenum; a portion of the colon; the pancreas; the aorta, and the cæliac axis: and I would earnestly recommend to you, gentlemen, to study both here and in the other regions the position of the parts relatively to one another.

The **Right Hypochondriac** region contains nearly the whole of the right lobe of the liver; the angle of the ascending and a portion of the transverse colon; the greater part of the duodenum; the renal capsule, and the upper portion of the right kidney.

The **Left Hypochondriac** region contains the rounded cardiac portion of the stomach, at all times, and a very large portion of the organ when distended; the left angle of the colon; the spleen, and a small portion of the left kidney, with its renal capsule.

The **Umbilical** region is chiefly occupied by a portion of the arch of the colon, the omentum, and the small intestines. It contains, likewise, the mesentery and its glands, the aorta, and the vena cava.

The **Right Lumbar** region contains the cæcum, the ascending colon, the lower and middle portion of the kidney, and a portion of the ureter.

The **Left Lumbar** region is occupied by the descending colon, the left kidney, and the ureter. The small intestines likewise occupy the lumbar region on either side.

The **Pubic** or **Hypogastric** region contains in children, the urinary bladder, with portions of the ureters (also in adults if they be distended), the convolutions of the small intestines, and in the female, the uterus and its appendages.

The **Right Iliac** region contains the "cul-de-sac" of the caput coli; the vermiform process, and the iliac vessels.

The **Left Iliac** region contains the sigmoid flexure of the colon, and the iliac vessels of that side.

Methods Employed in the Physical Examinations of the Abdomen.

They are the same, with the exception of succussion, as those practised in exploration of the thorax. But they differ in their relative importance. In thoracic examinations, auscultation is the most important method; while in abdominal examinations, auscultation is only employed in determining the existence of aneurisms and of pregnancy. Percussion and palpation are the means by which we gain the most useful information concerning the contents of the abdominal cavity.

Before considering the signs which indicate the changes occurring in the different affections of the abdominal organs, I will briefly notice the different methods of exploration.

Inspection.—By it we note alterations in the shape and movements of the abdomen. It is most satisfactorily performed with the patient lying on the back, with the thighs slightly flexed. In health, the abdomen is of an oval form, marked by elevations and depressions corresponding to the abdominal muscles, the umbilicus, and in some degree by the form of the subjacent viscera; it is larger relatively to the size of the chest, in children, than in adults, more rotund, and broader inferiorly, in females than in males.

Alterations in its shape due to disease, we find to consist, *First*, in *enlargement*, which may be general and symmetrical, as in ascites; or partial and irregular, from tumors, hypertrophy of organs, as the liver and spleen; or from tympanitic distension of portions of the intestines by gas, as of the colon in typhoid fever. *Second*, it may be *retracted* as in extreme emaciation, and in several forms of cerebral disease; especially is this noticeable in the tubercular meningitis of children.

The normal movements of the abdominal walls are con-

nected with the respiration, so that they bear a certain relation to the movements of the chest walls, being often increased when the latter are arrested, and *vice versâ.* Thus abdominal movements are increased in pleurisy, pneumonia, pericarditis, etc.; but decreased or wholly suspended when disease causes abdominal pain, or in peritonitis.

Not unfrequently, when inspecting the abdomen, a distinct pulsation will be visible in the epigastric region, which frequently is mistaken for aneurism. The superficial abdominal veins are also at times visibly enlarged, indicating an obstruction to the current of blood either in the portal system, as in cirrhosis, or in the vena cava.

Mensuration is mainly useful in determining the exact increase or decrease of abdominal dropsies, visceral enlargements, and tumors. It is performed by means of a graduated tape.

Palpation.—This method of exploration often furnishes important information. It may be performed with the tips of the fingers, with the whole hand, or with both hands, and the pressure may be slight or forcible, continuous or alternate. In order to obtain the greatest amount of information by palpation, the patient should be placed in a horizontal position, with the head slightly raised and the thighs flexed; sometimes it is necessary to place him in a standing position, or leaning forward.

Indications Furnished by Palpation.—By it we can determine the size and position of the viscera, the existence of tumors and swellings, whether they are superficial or deep, large or small, hard or soft, smooth or nodulated, movable or fixed, solid or fluid, and whether or not they possess a motion of their own. We can also ascertain if tenderness exist in any portion of the abdominal cavity, and if pain is increased or relieved by firm pressure.

Percussion.—In the performance of abdominal percussion,

the patient should be placed in the same position as for palpation, and the percussion should be for the most part mediate. In exploring the abdomen by means of percussion, the plessimeter (the finger being the best) should first be placed immediately below the xiphoid cartilage, pressed firmly down and carried along the median line towards the pubes, striking it all the way, now forcibly, now gently. The different tones which the stomach, colon, and small intestines furnish will be distinctly heard. The percussion should then be made laterally, alternately to the one side and then to the other, until the whole surface is percussed (Bennet). In this manner the different percussion sounds of the stomach, large intestines, small intestines, and the solid visceræ will be readily distinguished. Thus the percussion sound elicited over a healthy abdomen may be *dull*, *flat*, or *tympanitic*. Over the central portion of the liver, spleen, and kidneys, the percussion sound is flat; over that portion of either of these organs where they overlap the intestines or stomach it is dull, with a tympanitic quality. Over the stomach and intestines it is tympanitic, more so over the former than the latter. When fluid occupies the abdominal cavity, over the fluid the percussion sound will be flat. A distended bladder or uterus; an enlarged liver, spleen, kidney, or mesenteric gland; ovarian, aneurismal, and other tumors, are recognized and their limits determined by the unnatural and increased area of the percussion flatness; while, on the other hand, gaseous distension of the stomach or intestines is recognized by the increased area of tympanitic percussion.

Auscultation.—For the physical exploration of the abdomen, auscultation is only of service, as we have said before, in the diagnosis of aneurisms, and in detecting the pulsations of the fœtal heart, and the utero-placental murmur in the pregnant state.

Our examinations of the *abdominal viscera* are sometimes in-

terfered with and rendered uncertain by changes that occur in the abdominal walls. Generally, the abdominal walls are sufficiently thin, soft, and movable for us to determine with considerable accuracy the situation and condition of the contained organs: if, however, everything is masked by layer upon layer of fat, as in some cases of obesity, abdominal examinations will be unsatisfactory. An *œdematous condition* of the abdominal walls, as in Bright's disease, may also prevent us from ascertaining the condition of the viscera. When this occurs, the surface of the abdomen presents a smooth, even, shining, waxy appearance, and pits on firm pressure. *Superficial abscess* of the abdominal walls also occurs occasionally, which interferes greatly with the exploration of the abdominal cavity. You can recognize these by the circumscribed bulging, by tenderness on slight pressure, by the redness of the surface, and by the characteristic fluctuation of a superficial abscess.

The abdominal muscles are sometimes abnormally developed, or unnaturally rigid as in tetanus, rheumatic inflammation, and in the early stage of peritonitis, and this somewhat interferes with our examinations.

Diseased Conditions of the Peritoneum.

Under this head may be included the various results of inflammatory action, ascites, etc. They all give rise to more or less abdominal enlargement.

Acute Peritonitis.—By *inspection* we recognize in acute peritonitis either a diminution or an entire suspension of abdominal respiration, the breathing becoming entirely thoracic. The abdomen enlarges, becomes unnaturally tympanitic, and there is marked tenderness on firm pressure. The comparative results of *firm* and *slight* pressure is one of the strong diagnostic marks of peritoneal inflammation.

Chronic Peritonitis is almost always connected with tuber-

cular and cancerous deposits in the substance and over the free surface of the peritoneum; and in addition to the tympanitic distension of the abdomen, and the tenderness on firm pressure noticed in acute peritonitis, fluid accumulations take place in the peritoneal cavity.

Ascites.—A collection of fluid from any cause in the peritoneal cavity is termed ascites.

Inspection.—The abdomen is always *uniformly* enlarged, and the movements of the abdomen in respiration are either suspended or limited to the epigastric region. The superficial abdominal veins, if the ascites depend upon disease of the liver, will often be found enlarged.

Palpation.—If the palmar surface of the hand be applied to the side of the abdomen at the level of the fluid, and light percussion be performed on the opposite side, a sense of fluctuation will be communicated to the hand.

Percussion gives flatness at the lower and most depending portion of the abdomen; while at the upper portion above the level of the fluid, there is a drum-like, tympanitic resonance. When the patient is in the erect posture, the tympanitic resonance is confined to the epigastrium and upper portion of the umbilical region. If in a recumbent posture, the tympanitic resonance will extend into the hypogastrium; if placed on either side, the lumbar region of the opposite side becomes tympanitic. Other abnormal changes that occur in the peritoneum are connected with deposits, that may be classed under the head of abdominal tumors.

LESSON XV.

Physical Signs of the Abnormal Changes in the Different Abdominal Organs.—Stomach.—Intestines.—Liver.—Spleen.

Stomach.—When this viscus is empty, or not distended with gas or food, there is on *inspection* no visible prominence to indicate its position, nor does *palpation* furnish us any information as to its condition.

Percussion gives a metallic or tympanitic resonance which enables us to distinguish it from the surrounding viscera. The line of dulness which marks the lower border of the liver and the inner border of the spleen determines the upper and lateral boundaries of the stomach. To ascertain the lower border, percuss gently downwards from this line of dulness, until a slight change in the percussion sound indicates that you have reached the transverse colon (see fig. 17). Opposite the inner border of the seventh rib the cardiac orifice or extremity of the organ is situated. At a point a little below the lower border of the liver, within a line drawn from the right nipple to the umbilicus, the pyloric orifice of the organ is situated. The lower margin of the great "cul-de-sac" is found generally near the umbilicus.

Diminution in the size of the stomach cannot be recognized by physical exploration. An increase in size or distension of the stomach may occur from an accumulation of gas, from large quantities of fluids or solids taken into the stomach; or it may be enlarged within circumscribed spaces from cancerous deposit in its walls.

Gaseous or **Tympanitic** distension of the stomach is recognized by an increase in the area of the characteristic tympanitic resonance of the organ. A *distended* condition of the stomach from food or drink is recognized by an absence of the normal resonance, and by a continuation of the dull percussion of the liver and spleen downwards to the umbilicus. A moderate amount of fluid or solid in the stomach can be determined by a limited area of dulness corresponding to the "cul-de-sac" of the organ.

Cancer of the Stomach most frequently has its seat at the pyloric extremity of the organ; but in whatever portion of the organ it may be developed, it can be recognized by circumscribed dulness on percussion, where in health, when the stomach is empty, we should have tympanitic resonance. The percussion dulness elicited over the cancerous mass, however, has a hollow character which is readily distinguished from the flat percussion sound of a solid organ.

By palpation a nodulated mass is readily detected, corresponding to the area of percussion dulness, which is movable, easily grasped, and readily separated from the surrounding viscera. These signs, taken in connection with the attendant symptoms, are almost always sufficient for a positive diagnosis.

Intestines.—In a normal condition the large intestines furnishes a more amphoric percussion sound than the stomach. When, however, it is filled with fluid or solid accumulations, the situation of these accumulations can be marked out on the surface by the dulness on percussion.

The peculiar feeling of such enlargements will generally enable you to decide as to their true character; they feel like no other tumors. On being examined through the abdominal walls, they are felt to be hard and resistant; but if one finger be pressed steadily upon them for one or two minutes, they will at last indent like a hard snowball; and as there is not the slightest elasticity about them, the indentation remains

after the pressure is removed (Simpson). As these accumulations most frequently collect in the descending colon, the percussion sound over this portion is usually less resonant than over the ascending or transverse colon. According to Dr. Bennet, in a practical point of view it is often useful to determine whether a purgative by the mouth or an enema is likely to open the bowels most rapidly. If there is dulness in the left iliac fossa in the track of the descending colon, that portion of the intestine must be full of fæces, and an enema is indicated. If, on the other hand, the sound in the left iliac fossa is tympanitic, and in the right dull, an enema is of little service, as it will not extend to the cæcum, and purgatives by the mouth are indicated. Sometimes the whole colon, or the transverse portion, or, what is more common, the sigmoid flexure of the large intestine, becomes distended with fæcal accumulations, giving rise to circumscribed abdominal enlargement and to flatness on percussion over that portion of the abdomen which corresponds to the situation of the intestines. Care must be taken not to confound this condition with an enlarged liver, spleen, tumors, etc. The percussion sound over the small intestines, unless they are distended with gas, is higher pitched and less amphoric than that of the surrounding large intestines. There are no physical signs to indicate the abnormal changes which occur in this position of the alimentary canal, except an increase in the tympanitic resonance which exists when they are distended with gas.

Liver.

Our diagnosis in any case of hepatic disease rests mainly on the size, form, and position of the liver as determined by percussion and palpation. The first step, then, in studying the physical signs indicative of disease of this organ, is to become familiar with its normal boundaries. In its healthy state, the right lobe of the liver occupies the right hypochon-

drium, lying completely in the hollow formed by the diaphragm, rarely descending below the free border of the ribs, or extending upwards above the fifth intercostal space; the left lobe reaches across to the left of the median line an inch or more (see fig. 17).

The upper boundary of the organ is determined by percussing with moderate force from the right nipple downwards until the flatness of the percussion sound indicates that a solid organ has been reached; draw a line at this point. Then percuss downwards from the axilla, and from a point a little to the right of the median line in front, in the same manner, until the same change occurs in the percussion sound; a line drawn through the points which mark the change in the percussion sound along these lines determines the upper boundary of the lines; and it will be found generally to correspond to the base of the ensiform cartilage on the median line in front to the fifth intercostal space on the line of the right nipple, to the seventh rib in the axillary region, and to the ninth rib in the dorsal region. The lower boundary of the organ is determined by percussing downwards from the line of flatness already determined, and noting the points where the tympanitic sounds of the stomach and large intestine occur, which will generally be found to correspond anteriorly with the free border of the ribs, and to a point three inches below the ensiform cartilage on the median line; laterally, in the axillary region to the tenth intercostal space, and posteriorly, in the dorsal region to the twelfth rib. The flatness of the left lobe usually reaches two inches to the left of the median line. The whole margin of the line, except where it comes in contact with the apex of the heart through the medium of the diaphragm, may thus be determined and marked out on the surface. The vertical measurements will be found very nearly as follows: Three inches on the right of the median line in front; four inches on a line with the right nipple;

four and one-half inches in the axillary region; and four inches posteriorly in the dorsal regions. The smooth edge of the lower margin of the liver in health, especially in thin subjects, can be distinctly felt behind the free border of the ribs.

The healthy liver in its normal position evidently influences very little the percussion sound over the soft half of the abdomen, which, as has already been stated, when the organs there situated are normal and empty, yields tympanitic resonance from immediately below the margin of the ribs to the pubes; if, therefore, the percussion sound is dull, and the dulness is uninterrupted to the margin of the ribs on the right side, we have good reason for believing that the liver is the organ diseased.

The *normal boundaries* of the liver already defined may be greatly altered without any abnormal change occurring in the organ itself. These normal changes, unless remembered, may lead to errors in diagnosis. Thus, congenital malformations may give rise to an increase in the area of hepatic dulness. An accurate history of the patient, however, will keep us from error in such cases. In the examination of children, it should also be remembered that the liver is proportionally larger than in adults.

The practice of tight lacing may cause displacement and malformation of the liver, and thus give rise to apparent hepatic enlargement; the marks which this practice leaves on the chest-walls will be sufficient to attract our attention, and so prevent mistake.

Diseases of the thoracic organs and abnormal conditions of the other abdominal viscera sometimes cause displacement of the liver, simulating very closely hepatic enlargement; these we will consider under the head of *differential diagnosis* of diseases of the liver.

Variations in the Size of the Liver in Hepatic Diseases.

Variations in the size of the liver occur in almost every disease to which it is subject.

It is *increased* in size, in *fatty liver*, in *waxy liver*, in *hydatid tumor*, in *abscess of liver*, in *congestion*, in *acute hepatitis*, in *obstruction of the bile ducts*, and in *cancer*. It is *diminished* in size in *cirrhosis* and in *acute atrophy*. Enlargements of the liver

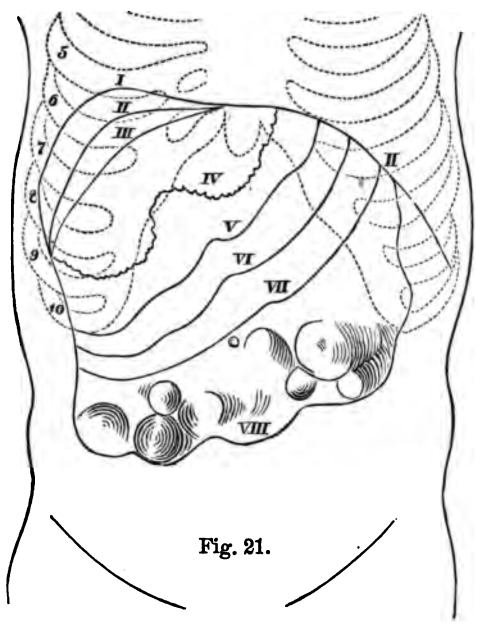


Fig. 21.

The volume of the liver in various diseases. 5-10, Ribs. I, Position of the diaphragm in the highest degree of tumefaction of the liver (carcinoma). II, II, Normal position of the diaphragm. II, III, Relative dulness. III, Position of the diaphragm at the anterior wall of the chest, at the same time the line of dulness of the normal liver. IV, Edge of liver in cirrhosis. V, In the normal liver. VI, Fatty liver. VII, Amyloid liver. VIII, Cancer, leukæmia, adenoma. All of proportional size.—After RINDFLEISCH.

were divided by Dr. Bright into smooth and irregular. Dr. Murcherson has divided them into painless and painful enlargements. Both of these divisions, it seems to me, have their objections; and in giving the physical signs of the various diseases accompanied by enlargement of the organ, it is hardly practicable to adopt either of them exclusively.

Fatty Liver.—In fatty degeneration of the liver the organ is uniformly enlarged; there are no circumscribed bulgings; its normal shape is unaltered; there is no expansion of the lower ribs; it *never* gives rise to ascites, and it is not attended by any visible enlargement of the superficial veins. On palpation below the margin of the ribs on the right side, and in the epigastrium, a soft cushion-like enlargement is readily detected, extending not unfrequently as low as the umbilicus; its outer surface is smooth, and its lower margin is rounded, and not well defined; it is *never tender* on pressure. On percussion there is flatness over the surface of the abdomen corresponding to the enlargement.

Waxy Liver.—In waxy or amyloid degeneration, the organ undergoes greater enlargement than in fatty degeneration; it often becomes so large as to fill the whole abdominal cavity; its growth is slow, usually extending over a period of two or three years. The enlargement is uniform, and the area of hepatic dulness is consequently increased on percussion in every direction,—more, however, in front than behind. There is often on inspection a visible tumor below the margin of the ribs, but there is no bulging of the ribs themselves. On palpation, that portion of the organ below the ribs is dense, firm, and resistant; the outer surface is smooth; the lower margin is sharp and well defined. Pain and tenderness are rarely present, so that the portion of the organ below the ribs, as in fatty degeneration, can be manipulated without giving the patient any inconvenience. When excessive, it is *almost always accompanied by ascites.*

Hydatid Tumors of the Liver.—Hydatid cysts, when small or deep-seated, cannot be detected by physical examination; but when large or superficially seated hydatid cysts are recognized by abnormal increase in the area of hepatic dulness,—the outline of the dulness being irregular,—and by the globular form of the enlargement on the surface of the organ. Sometimes

these cysts are so large as to cause the organ to fill a large portion of the abdominal and encroach on the right pleural cavity; the natural form of the organ is greatly altered, the enlargements taking place more in one direction than in another. Sometimes percussion over a large hydatid cyst will give rise to a characteristic vibration known as hydatid fremitus; this vibration is produced by the impulse of the smaller cysts that are contained in a large one. A hydatid liver encroaching on the thoracic cavity gives rise to flatness on percussion, and absence of respiratory sound from the base of the chest upwards as far as the tumor extends, the upper boundary of the flatness being arched. It is distinguished from pleuritic effusion in that a change in the position of the body does not change the line of percussion dulness. On palpation, sometimes the enlarged portion below the ribs has an elastic or even fluctuating feel, and if a large cyst be near the surface it may give rise to a sense of fluctuation; the surface over these enlargements is smooth, the organ is not *tender* on pressure, and its growth is slow.

Abscess of the Liver.—When hepatic abscesses exist, from whatever cause, it depends entirely upon their situation whether an external tumor is produced or not; if the abscess occupies the posterior portion of the right lobe, the liver is pushed down so that its margin is perceptible below the free border of the ribs, and the flatness on the right side, posteriorly, extends higher than natural. When an abscess is superficial, and is pointing externally, a distinct tumor is felt below the ribs; and there is always more or less bulging of the ribs if the right lobe is affected. The situation of the tumor varies according as the right or left lobe is affected; a tumor arising from such a cause is easily traced as connected with the liver, of which it evidently forms a part, the flatness on percussion being continuous. Sometimes the organ is enormously enlarged, its free border extending below the um-

bilicus, the surface of the enlargement being smooth, and usually tender on pressure. The sensation to the examiner on making light pressure will be soft and fluctuating, or that of elastic tenseness. In some rare instances, abscesses produce an uneven or lobulated condition of the surface; under such circumstances it may be mistaken for cancer, unless the rational symptoms and history of the case be included in the elements of diagnosis. The enlargement goes on rapidly. With a correct history of the case, the diagnosis is easily made.

Congestion of the Liver.—The most simple form of hepatic enlargement is that which results from congestion. When the liver is thus loaded with blood, a slight fulness is perceptible on the right side. On palpation, the space immediately below the ribs is occupied by a smooth, hard, resisting enlargement corresponding to the natural shape of the liver, which is not usually tender on pressure. There is no well-defined tumor.

On percussion a flat sound is elicited, an inch or two below the margin of the ribs, on the right side.

Obstruction of the Bile Ducts.—An enlargement of the liver similar to the one just noticed occurs, when from any cause there is obstruction in the biliary ducts, and an accumulation of bile *takes place* in the liver. Sometimes when this occurs, in addition to the general enlargement detected by the slight uniform increase in the normal area of hepatic dulness, a globular projection is detected at a point corresponding to the transverse fissure of the liver, with the elastic feel of deep-seated fluid; this tumor is the distended gall bladder.

Acute Hepatitis.—The physical signs of acute hepatitis do not differ materially from those of simple congestion, except in the excessive tenderness that exists on pressure over that portion of the organ which descends below the ribs.

Cancer of the Liver.—In most cases of cancer, the diagnosis is easily made.

On **Percussion** the area of the hepatic dulness is always increased, sometimes extremely so; the organ is found to occupy the greater portion of the epigastrium, extending beyond the median line, into the left hypochondrium, pushing the diaphragm upwards, and often descending below the ribs, to the crest of the ilium.

On **Palpation**, irregular nodules of various size are distincly felt through the abdominal walls, projecting from the surface of that portion of the enlarged organ which is below the free border of the ribs; these prominences are usually harder than the surrounding hepatic tissue, and there is more or less *tenderness* on pressure over them. Cancer of the liver may or may not be accompanied by ascites.

Occasionally the surface of the liver in cancer is perfectly smooth, and in such cases you will be unable to detect the disease by the physical signs.

Decrease in the size of the Liver.

The liver is diminished in size in cirrhosis, and in acute atrophy.

Cirrhosis of the Liver.—In fully developed cases of cirrhosis of the liver, the organ is always diminished in size, and there is more or less abdominal dropsy. The only evidence of this disease furnished by inspection is a visible enlargement of the superficial veins.

Percussion.—The area of the normal hepatic flatness is diminished; its limits are determined as follows: If the abdominal cavity is distended with dropsical accumulations, the patient should be placed partly on the left side, so that the fluid will gravitate from the hepatic region; the percussion flatness then, instead of extending to the free border of the ribs, will often give place to tympanitic resonance, an inch or more above their free margin, and instead, also, of extending across the median line into the left hypochondrium, will rarely

reach that line; while the vertical measurement of hepatic dulness on a line with the right nipple does not often exceed two and a half inches.

Palpation.—By firm pressure with the ends of the fingers upwards, little nodules will often be felt on the under surface of the organ; sometimes when the distension of the abdomen from dropsical accumulation has been very great, we can get no information by palpation until after the performance of paracentesis.

Atrophy of the Liver.—The only physical sign of atrophy of the liver is obtained from rapid diminution in the size of the organ, as ascertained by percussion, its surface remaining smooth; the diminution never being accompanied with ascites.

Differential Diagnosis of Diseases of the Liver.

The sources which may lead to error in the conclusion that the liver is the seat of disease when it is not, are, fæcal accumulations in the ascending and transverse colon; enlargement of the right kidney; diseases of the stomach; displacement of the liver by disease in the right side of the chest; enlargement of the spleen; tumors of the omentum, and ovarian tumors.

Fæcal Accumulations.—To distinguish these accumulations from enlargement of the liver, by physical examination, is always difficult and sometimes impossible; they give rise to a distinct tumor below the border of the ribs which by percussion and palpation seem to be continuous and connected with the liver. The characteristic feel of these fæcal enlargements already referred to will assist you somewhat. The differential diagnosis sometimes, however, can only be made after making trial of remedies which by acting freely on the bowels remove the accumulations, and cause the disappearance of the supposed hepatic enlargement.

Disease of the Right Kidney.—The right kidney sometimes enlarges in such a manner as to present itself as a tumor, extending from the under surface of the right lobe of the liver. If it has attained considerable size, it may therefore seem to be continuous with the liver as a growth from its substance. It may be distinguished from the liver by carefully examining its relation to the ribs; as the patient lies on his back, the enlargement, instead of passing up under the ribs, dips down, so as to allow the finger to pass vertically between the tumor and the ribs.

Diseases of the Stomach.—The only disease of the stomach which we are likely to confound with enlargement of the liver is cancer. It can, however, usually be readily distinguished from it by the tympanitic quality of the percussion sound over the cancerous mass, and by the mobility of the supposed enlargement.

Displacements of the Liver downwards from extensive pleuritic effusion, and from pneumo-thorax, are recognized by the presence of the physical signs which indicate these thoracic diseases.

Enlargement of the Spleen and **Ovarian Tumors** are distinguished from enlargements of the liver by the shape of the tumor, and by the continuous and increasing flatness of the percussion sound as we pass towards the normal position of these organs.

Spleen.

The spleen, from the obscurity which involves its natural function, so that its affections usually give rise to but negative general symptoms, and from its comparatively isolated situation, often presents greater difficulties in the diagnosis of its morbid conditions than is the case with any other abdominal organ. In health this organ occupies the upper portion of the left hypochondriac region, its lower

border touches the left kidney, while its convex surface occupies the concavity of the diaphragm. It is bounded posteriorly above by the lower border of the ninth rib; anteriorly by the stomach and left colon; and inferiorly by the free margins of the ribs. It is about four inches long and three inches wide. In its healthy condition, inspection and palpation furnish only negative results.

Percussion.—To determine the boundaries of the spleen by percussion, it is necessary that the patient should lie on the

Fig. 22.

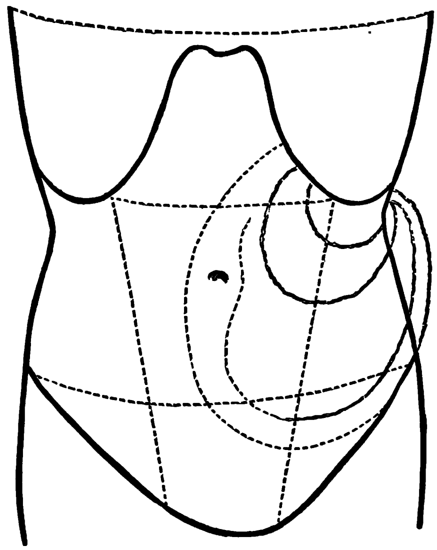


Diagram representing the different Areas occupied by the Spleen in its various Enlargements into the Abdominal Cavity.—Bright.

right side. Its anterior border is readily determined by the tympanitic resonance of the stomach and intestines. Inferiorly, where the organ comes in contact with the kidney, it is difficult and often impossible to determine its boundary. Its superior border corresponds to the line which marks the change from flatness to pulmonary resonance.

In disease, the spleen may be increased or diminished in

size. We are rarely, if ever, able to recognize atrophy of the spleen during life. In most cases of splenic disease there is neither pain nor tenderness. The only reliable physical signs of disease of the organ are connected with its enlargements. The tumor produced by the enlargement of the organ can scarcely be overlooked. Its characteristics are a smooth, oblong, solid heap, felt immediately beneath the integuments, extending from under the ribs on the left side, a little behind the origin of the cartilages, often advancing to the median line in one direction, and descending to the crest of the ilium in the other, filling the left lumbar region at its upper part. This tumor is usually movable, rounded at its upper portion, and presenting an edge more or less sharp in front, where it is often notched and fissured.

The principal tumors which may be mistaken for an enlarged spleen are, chronic abscess of the integuments, cancer of the stomach, enlargement of the left lobe of the liver, diseased omentum, fæcal accumulation in the colon, disease of the left kidney, and ovarian disease.

Chronic Abscess in the Abdominal Wall sometimes occurs precisely in the situation of an enlarged spleen, but it is easily distinguishable from it, by the superficial character of the swelling, and by its being too soft to belong to an internal viscus.

Cancerous Deposit in the cardiac extremity of the stomach sometimes gives rise to a tumor, which, from its being deeper than the abdominal walls, and descending from the margin of the ribs, might be mistaken for an enlarged spleen. One of the best distinctive marks will be found in the sound elicited by forcible percussion, which, when the stomach is diseased, has more or less of a tympanitic resonance, while the tumor is harder to the feel than an enlarged spleen.

Enlarged Left Lobe of the Liver is easily distinguished from enlarged spleen; for the margin of the tumor can be

traced running towards the right, and not towards the left, as is the case with enlarged spleen.

Cancerous and **Tubercular Enlargements** of the omentum are distinguished from an enlarged spleen by the fact, that they extend across the abdomen, and cannot be traced backwards; they do not ascend behind the ribs, and are rough, hard, and uneven.

Fæcal Accumulation in the intestines is a source of very great difficulty in this diagnosis, for when it takes place in the descending colon, at the sigmoid flexure, the enlargement assumes very nearly the situation of an enlarged spleen, and is scarcely to be distinguished from it, except by its peculiar feel, by its history, and by the results of cathartics; nor must we without the most persevering employment of purgatives and enemata conclude that the intestines have been emptied.

The **Left Kidney** sometimes enlarges towards the left hypochondrium, and presents a tumor very nearly in the situation of an enlarged spleen; but by tracing it back towards the loins, we shall find that its chief bulk is situated much farther back, and that it is much more fixed, so that if the patient is placed on his hands and knees, it does not fall forwards. By observing the rules for the diagnosis of ovarian tumors, we shall easily distinguish them from enlarged spleen (Bright).

LESSON XVI.

Physical Signs of the Abnormal Changes in the Different Abdominal Organs—Continued.

Kidneys, Bladder, Uterus, Ovaries, Aneurisms, Omentum, Mesentery.

Kidneys.—The kidneys in health are situated in the lumbar regions, as shown in fig. 2, in the space corresponding to the two lower dorsal, and the two upper lumbar vertebræ; the right is a little lower than the left. Superficially, they extend from the eleventh rib to the crest of the ilium. The right is bounded, above by the posterior and inferior portion of the right lobe of the liver; below by the cœcum; anteriorly by the ascending colon, and posteriorly by the diaphragm and quadratus lumborum. The left is bounded, above by the spleen; anteriorly and inferiorly by the colon, and posteriorly by the diaphragm and quadratus lumborum.

In disease, the kidneys may be increased or diminished in size. Atrophy, or diminution in the size of the kidneys, can rarely be determined by physical examination, so that enlargements are the only conditions to which physical exploration is applicable. The kidneys may be enlarged from calculi pyclitis, which sometimes converts the kidneys into a bag of pus; cancerous and tubercular deposits, hydatid cysts, and simple distension, the result of obstruction of a ureter. A tumor is also sometimes developed at the upper border of a kidney, from disease of the supra-renal capsule.

Inspection rarely furnishes any evidence of enlargement of a kidney; and, not unfrequently, after examining the lumbar

regions by *palpation* with great care, and by careful comparison of the two sides, we are unable to recognize any change in the size of these organs; but as soon as we place our hand anteriorly, and press firmly towards the normal position of the kidney, a tumor is felt; then, by pressing the tumor backwards, our other hand resting on the lumbar region of the same side, we at once determine that this tumor has its origin in the kidney. The part of the abdomen in which a renal tumor is felt, will vary, according to the nature of the disease and the portion of the kidney involved.

Percussion.—In percussing the kidneys, the patient should be placed on the abdomen and chest, which posture will allow fluid accumulations in the abdominal cavity to gravitate forwards, and the intestines to float upwards. The external margin of the kidneys can then be readily determined by the tympanitic note of the intestines around their external circumference, except where they are in relation to the vertebræ. In health, the outlines of the renal dulness will correspond to the limits already given. Any enlargement of these organs will cause a corresponding increase in the area of renal dulness; but we cannot by physical examination establish the exact nature of the disease to which the increase in the organ is due.

The sources of error in the diagnosis of enlargements of the kidneys vary, according as the right or left kidney is the seat of disease.

Enlargement of the right kidney may be mistaken for an enlargement of the right lobe of the liver, for cancer of the pyloric orifice of the stomach, for fæcal distension of the colon, and for enlargement of the right ovary. The rules for distinguishing it from each of these have been already given in the previous section, as likewise, for distinguishing enlargements of the left kidney from enlargement of the spleen, the left ovary, and from fæcal distension of the descending colon.

Movable Kidney.—This is not properly a disease, but a peculiarity of structure in certain individuals. The attachments of the kidneys, or more generally of only one kidney, are so loose that the organ can be displaced, either vertically or laterally, to a considerable degree, and this may so approach the anterior abdominal walls, as to be readily felt through them. It can be detected by drawing up the feet, and retracting the abdomen, then grasping the tumor with the palm of the hand. It has a smooth rounded feel, and differs from mesenteric tumors or fæcal accumulations in wholly disappearing on gentle pressure into the abdominal cavity, so that it cannot be felt.

Bladder.—When the bladder is empty, its position cannot be determined by physical exploration; it can only be detected when it is distended, and rises above the pubes; when this is the case a tumor is visible in the hypogastric region, which on palpation is smooth and oval. Its circular margin is easily made out by observing the tympanitic sound of the intestines on the one hand, and the dull sound produced by the bladder on the other. In infants, the bladder is not as deep in the pelvis as in adults; consequently a smaller quantity of urine in the bladder can be recognized. A distended bladder can only be mistaken in the female for a gravid uterus, or a uterine tumor; the use of a catheter removes all doubts.

Uterus.—The unimpregnated uterus in its normal state is situated in the lower part of the hypogastrium, and is inaccessible to the touch, externally, or to percusion, but when normally developed by impregnation, or abnormally by disease, palpation, percussion, and auscultation furnish us with important information.

In pregnancy, at the end of the second month, a dull sound on percussion, just above the pubes, indicates the development of the uterus; later, as the uterus increases in volume, and rises into the abdomen, we are able by the oval tumor felt

in the hypogastrium, and by the circumscribed area of dulness, corresponding to the situation of the tumor, to establish strong presumptive evidence of pregnancy. The presumption becomes strengthened, if the area of the dulness increases with the regularity proper to gestation. But percussion and palpation are insufficient to determine whether the development of the uterus is due to pregnancy, or to some morbid deposit in its walls or cavity, as fibrous tumors, etc.

After the end of the fifth month, the evidence furnished by both these methods is inferior to auscultation.

Rules for Performing Uterine Auscultation.—The female should be placed on her back with her thighs slightly flexed, so as to relax the abdominal muscles; sometimes it is well to incline the body from one side to the other, or forwards so as to withdraw the pressure of the uterus from the pelvic arteries. The abdomen should be uncovered, as the sounds to be examined are of slight intensity, and very circumscribed; their study demands close attention and perfect silence. The stethoscope is always to be preferred, and the uterine tumor should be auscultated successively at different points.

After the fourth month of gestation, if the uterus contains a living fœtus, we may hear three distinct sounds,—the *Placental Bruit*, which is evidently connected with the circulation of the mother; the *Fœtal Heart*, and the *Funic Soufflé*, which are connected with the circulation of the fœtus.

Placental Bruit.—This sound is single, intermitting, and in character, is a combination of the blowing and hissing sounds. It increases in intensity up to the period of labor. It is believed to depend upon the rapid passage of blood from the arteries into the distended venous sinuses. It is synchronous with the maternal pulse, is subject to the same variations, and is always heard before the pulsation of the fœtal heart.

The **Area** over which it is audible varies; in some instances it is limited to a single point, in others it is audible over a

surface of three or four inches, and in a few it is heard over the whole uterine tumor, although there will always be one spot of greatest intensity, corresponding to the placental attachment. It is also intensified by uterine contractions.

During the first half of pregnancy it is usually heard with greatest intensity in the median line, a little above the pubes; after the fifth month at the lateral and inferior borders of the uterus; and next in order of time it will be heard at the fundus.

This sound may be confounded with the respiratory murmur of the mother, and with intestinal murmurs; these murmurs, however, are not synchronous with the pulse of the mother, and if this fact is remembered, there will be little difficulty in distinguishing them. As a proof of pregnancy, placental bruit is not positive, as it is sometimes heard in connection with uterine and ovarian tumors. It does not prove that the fœtus is alive, for it is heard for a long time after its death. Its negative evidence is of less value, for if the placenta is attached posteriorly, we may not be able to hear it, although pregnancy exist.

Funic Soufflé.—This sound is usually heard at a point quite remote from the placental bruit; it is short, feeble, and blowing in character, and corresponds in pregnancy with the fœtal pulsation. It is supposed to depend upon obstruction to the transmission of blood through the umbilical arteries, as from twirling or knotting of the funis, or from external pressure. It is not a constant, nor even a frequent sound, the conditions of its production being rarely met with.

Fœtal Heart Sound.—This sound consists of a succession of short, rapid, double pulsations, varying in frequency from 120 to 140 per minute. The first sound is short, feeble, and obscure, while the second, the one we usually hear, is loud and distinct, and may be heard generally over the body and limbs of the child. This sound has been aptly compared to the

ticking of a watch wrapped in a napkin, and is usually earliest heard at the middle of the fourth month. The frequency of the pulsations do not vary with the age of the fœtus.

The extent over which the fœtal heart sound is audible varies; usually it is transmitted over a space three or four inches square. The location of the sound is determined by the position of the fœtus. It has been stated that by drawing a horizontal line and dividing the uterus into equal parts, that whenever the maximum of intensity of the sound is below this line, it is a vertex presentation; when above, it is a breach; also, when the fœtal pulsations are heard low down in front on the left side, that the fœtus is in the first position; if heard below and in front on the right side, it is in the second position.

Twin pregnancy may sometimes be determined by the presence of heart sounds heard at distant points over the uterine tumor, and by the absence of synchronism in the two pulsations. The sources of deception in exploring for the fœtal heart sound are the liability of confounding the pulsation of the iliac arteries or abdominal aorta of the mother with it; in most cases their situation, comparative frequency, and absence of double pulsation will determine their character. But a difficulty will sometimes occur in discriminating between them when the natural pulse is very much increased in frequency and the fœtal diminished. Under such circumstances we must be guided by the character of the sound, and whether it is or is not synchronous with the radial pulse.

Again, in the early stage of pregnancy, the intensity and impulse of the maternal pulsation may render the feeble fœtal sound inaudible; this difficulty may be obviated by removing the pressure of the uterine tumor upon the subjacent arteries, which can be done by changing the posture of the mother.

During labor, our examinations should be made in the interval between uterine contractions.

In protracted labors auscultation is of value in indicating to us the time for manual or instrumental interference to save the life of the child. The indications of danger to the child are feebleness, or excessive frequency of the fœtal pulsation; irregularity in its rhythm; absence of the second sound; its complete cessation during uterine contraction, and the slowness of its return in the interval. Irregularity and feebleness are the most threatening to the life of the child. When the sound of the fœtal heart is heard it is a positive proof of pregnancy; but its absence is not always proof that pregnancy does not exist, for the fœtus may be dead, and in some rare cases the sounds may exist and be quite inaudible for a time, and then appear. This phenomenon is not easily accounted for.

Tumors of the Uterus, whether developed on its surface, in its walls, or within its cavity, give rise to enlargement of the organ, which causes it to occupy a position corresponding to that occupied by a gravid uterus. The position and extent of these enlargements are determined in the same manner as we determine the size and position of the uterus in pregnancy. Deposits in its walls or on its surface give rise to nodules which feel through the abdominal walls like hard balls, varying in size and shape, seldom occurring singly. The whole mass can usually be moved from one side to the other. The connection of these tumors with the uterus, as determined by the uterine sound, leave little doubt as to their true character, and by this means we readily distinguish them from all other abdominal tumors.

Ovaries.—The ovaries in a normal state lie in the pelvic cavity, and their position cannot be determined by physical exploration; but when they become the seat of those forms of disease which cause their enlargement, and have attained such dimensions that there is no longer room for them in the pelvic cavity, they ascend above the brim of the pelvis, and occupy

more or less space among the abdominal organs. As they pass out of the pelvis, they are first noticed in the right or left iliac region, according as the right or left ovary is affected, and they are then recognized as ovarian tumors. Before these ovarian enlargements have attained sufficient size to attract the attention of the patient, they will have reached a central position in the abdominal cavity. They are of more frequent occurrence than all other forms of abdominal tumors;

Fig. 23.

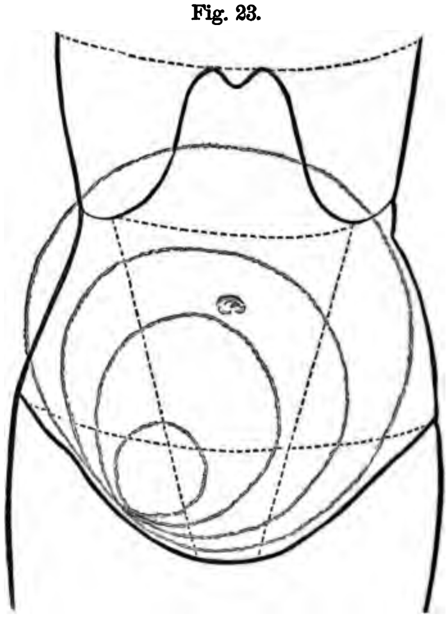


Diagram showing the Gradual Enlargement of a Tumor of the Right Ovary till it fills a large portion of the Abdominal Cavity forcing the Intestines into the Lumbar Regions.—BRIGHT.

and their existence is determined almost exclusively by the physical signs which they furnish.

Inspection.—In the early part of their development an uneven projection or prominence of one part of the abdomen will disclose the seat of the tumor, occupying usually the iliac or lumbar region of one side, and extending upwards to or beyond the umbilicus; while in more advanced cases no inequal-

ity will be visible, but the rounded form of the abdomen, while the patient lies on her back, offers a strong contrast to the flattened oval appearance of ascites, or the central rounded form of a uterus distended by pregnancy.

Palpation.—Ovarian tumors when small have a firm, elastic feel, but when large they are soft and fluctuating. In some cases, by passing the hand gently over the abdomen, the extent of the tumor will be readily appreciated. At other times the limits of the tumor cannot be ascertained by gentle palpation, for it occupies the whole of the abdomen except the concavity of the diaphragm. In such cases, by making firm, but not forcible pressure on various parts of the abdomen, we often detect at once a general sense of fluctuation, and ascertain inequalities which neither the eye nor the hand when passed gently over the surface will enable us to detect; sometimes if the abdomen is not tense, we can feel masses which convey the impression of more or less flattened or spherical bodies attached to the inside of a fluctuating tumor. In some cases the sense of fluctuation is very indistinct; in others, it is even more evident than in cases of extensive ascites.

Percussion.—The sound elicited on percussion is flat over that portion of the abdomen where the tumor comes in contact with the interior surface of the abdominal wall; while at the sides and above where the intestines have been pushed aside and upwards by the tumor, the percussion sound will be tympanitic; by this change in the percussion sound we are enabled to mark out the boundaries of the tumor.

Differential Diagnosis.—Ovarian tumors may be confounded in their diagnosis with *uterine enlargements*, as pregnancy, fibroid tumors of the uterus, etc., *ascites*, *hydatids of the omentum*, *fæcal accumulations in the intestines*, and *enlargements of the liver*, *spleen*, and *kidneys*.

They are distinguished from pregnancy by a stethoscopic

examination of the tumor, which reveals in the one case the sounds of the fœtal heart, and in the other their absence. They are distinguished from uterine tumors by their consistence, by their outline, by the difference in their connection and relative position to the uterus, and by the fact that in uterine tumors the cavity of the uterus as determined by the uterine sound is always elongated. The diagnosis between ovarian and abdominal dropsy is made, *First*, by observing the difference in the shape of the abdomen when the patient lies on her back; ovarian tumors project forwards in the centre, while in ascites the abdominal enlargement is uniform. *Second*, in ovarian tumors the percussion sound is dull, as high as the tumor extends, while at the same time there will be tympanitic resonance in the most depending portion of the abdominal cavity; in ascites the most depending portion of the abdomen is always flat, the percussion resonance being confined to the epigastric and umbilical regions. *Third*, in ovarian dropsy, the relative line of flatness and resonance is not altered by change in the posture of the patient, which is not the case in ascites.

Hydatids of the omentum form a class of tumors which you will be unable by physical signs to distinguish from ovarian tumors. The fact, however, that these omental enlargements are first noticed above the umbilicus and gradually enlarge downwards, while ovarian are first noticed low down in the abdomen and gradually enlarge upwards, will in most cases be sufficient for a diagnosis.

Fæcal accumulations in the large intestines may be mistaken for ovarian tumors; the peculiar feel of such tumors as has already been described will, however, enable you to distinguish them from ovarian tumors.

Abdominal Aneurism.—Aneurism of the abdominal aorta usually occurs at or near that portion of the vessel from which the cœliac axis is given off, and the rupture is usually in the

posterior wall of the artery. Aneurism of the cœliac axis, of the renal, hepatic, superior mesenteric, or splenic arteries is of very rare occurrence, and there are no means by which, if they do occur, they can be distinguished from aneurism of the abdominal aorta.

Inspection.—On inspecting the abdomen in a case of abdominal aneurism, a tumor in the epigastrium with an expansive impulse, usually may be discovered; in some cases, however, the closest inspection reveals nothing abnormal. When a tumor is present, the surface of the abdomen over it will be rounded and smooth. When the aneurism is of large size abdominal respiration may be diminished and thoracic increased. Enlargement of the superficial veins of the abdomen, and œdema of the lower extremities, are very rare phenomena.

Palpation.—By palpation we can determine approximately the size of the tumor, its position, and its impulse.

Aneurisms of the abdominal aorta are usually felt on the median line, or to the left of it, on the right side, or on both sides. They are *immovable.* The impulse, if one exist, is systolic and expansive, although when it is situated high up, there also may be a slight diastolic movement. A thrill is rarely perceptible. By comparing the pulsation in the arteries of the lower extremities with that of the upper, a feebleness of pulsation may be detected. The surface of the tumor when unruptured is rounded and smooth. Effusions of blood into the surrounding tissues may produce lobulations.

Percussion.—Dulness or flatness will exist over the tumor, although intestinal tympanitic tenderness, etc., may interfere with the value of this means of diagnosis.

Auscultation.—A systolic murmur, resembling that produced in aneurisms of the thoracic aorta, is usually heard directly over the tumor in front, or opposite to it, along the

lumbar spine; rarely, if ever, is a diastolic murmur heard, though a prolonged second sound often exists. In some cases the murmur is audible when the patient is in the recumbent posture, but disappears when he assumes an erect posture. In other cases all the physical signs of aneurism are absent, and still we are led to suspect its existence from the rational symptoms, the most prominent of which is a continuous, deep-seated, and at times paroxysmal pain in the lumbar region, which shoots down the thighs and around the abdomen.

Abdominal aneurism may be mistaken, *First*, for enlargement of various organs which by its size it has displaced, as the liver, kidney (especially the left), and the spleen. The presence, however, of the physical signs of aneurism in such cases will enable us to refer the apparent enlargement to its right source. *Second*, for neuralgia, rheumatism, colic, renal calculus, etc. The steady, persistent, long-continued, paroxysmal pain in the lumbar region, especially in male subjects, is strong presumptive evidence of aneurism, and if we have connected with this an immovable, although perhaps not pulsatile tumor along the course of the artery, the diagnosis of aneurism becomes almost positive. *Third*, for disease of the spine. Here the pain and possibly a curvature produced by an aneurism may mislead, but the physical signs of aneurism in most cases will correct the mistake. *Fourth*, for psoas or lumbar abscess. In this the shape of the tumor is elongated, and there is neither impulse nor murmur perceptible, which latter usually occurs even in those secondary tumors due to rupture of an aneurism when it appears in the lumbar region or even at Poupart's ligament. *Fifth*, for aortic pulsation. In aortic pulsation there is, however, absence of a murmur, of a thrill, of percussion dulness, and the impulse is quick and jerking, and not expansive as in aneurism. *Sixth*, for abdominal tumors. The tumors which are apt to be mistaken for aneurism are, enlarged left lobe of liver, cancer of the py-

lorus, enlarged mesenteric glands, fæcal accumulations, and hydro or pyo-nephritic kidney. In tumors the feel is usually harder, the impulse lifting, rarely expansive, and they may be accompanied by ascites, œdema, or enlarged abdominal veins, the infrequency of which in aneurism has already been alluded to. If a murmur occur with a non-aneurismal tumor, it may be made to disappear, in most instances, by causing the patient to assume a posture on his hands and knees, and the impulse may be diminished, or cease at the same time. Tumors are also usually movable, aneurisms immovable. In many cases of abdominal aneurism, the diagnosis is uncertain.

Omental Tumors.—The omentum may be the seat of a hydatid cyst, of cancer, or of tubercular deposits. These deposits or growths give rise to tumors which are readily detected through the abdominal walls, both by percussion and palpation; they are first recognized high up in the abdominal cavity, above the umbilicus, and gradually extend downwards. If there are no adhesions, you can push the tumors upwards, and from right to left; they are superficial, and their uneven surface is readily detected by passing the hand lightly over the surface of the abdomen. They are always more or less tender on firm pressure. The percussion sound elicited over these tumors is never flat, but has a tympanitic quality, caused by the subjacent intestines.

Mesenteric Enlargements occupy a position corresponding to that of the small intestines. They are beyond the reach of physical diagnosis, except as they occur in children, in the last stage of tabes mesenterica; then their diagnosis is of little practical use, their cure being hopeless.

EXAMINATION OF URINE.

LESSON XVII.

Introduction.—Reagents.—Solutions.—Apparatus for Making Urinary Examinations.—Qualitative Examinations of Urine.

Gentlemen :

You will find that the examination of the urine is frequently of great service in the diagnosis of disease. It may be accomplished either by a chemical examination of the soluble, or a microscopical examination of the insoluble portions, or by both.

I shall first direct your attention to the chemical examination. This involves the application of certain tests, and the performance of certain analyses—the former to ascertain the presence or absence of particular substances, the latter to determine the quantity or proportion in which they exist, when present.

The requisite apparatus, reagents, and solutions which you will find most useful and inexpensive in making these examinations, are comprised in the following list:

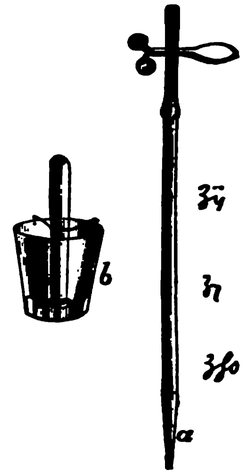
Apparatus.

Test tubes and rack.
Beaker (Fig. 26, *c*).
Burette and stand (Fig. 26, *a* and *b*).
Retort stand (Fig. 24, *a*).
Water bath (Fig. 24, *b*).
Water oven (Fig. 24, *c* and *d*)
Evaporating dish.
Spirit lamp or Bunsen's burner (Fig. 24, *e*).
Measuring pipette (Fig. 25, *a*).
Urinometer (Fig. 28).
Two conical glasses.
Two urine glasses.
A piece of black glass.
Litmus paper.
Swedish and German filter paper.
Apparatus for rapid filtration.
Balance turning with $\frac{1}{10}$ of a grain.
Suitable weights from $\frac{1}{10}$ of a grain to 10 grains.

FIG. 24.

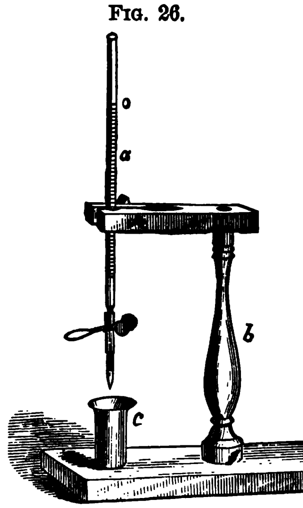
a, Retort Stand; b, Water Bath; c and d, Piffard's Water Oven; e, Bunsen Burner.

FIG. 25.



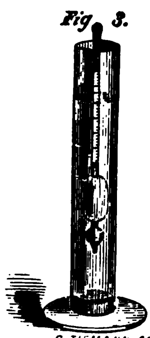
a, Measuring Pipette; b, arrangement for Fermentation Test.

FIG. 26.



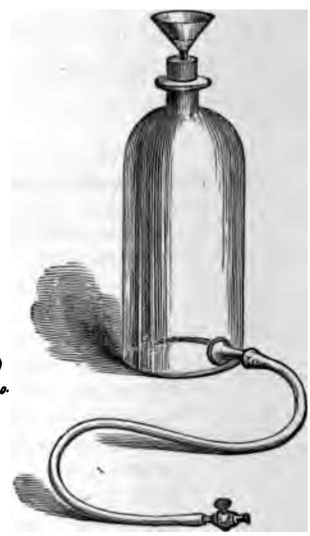
a, Mohr's Burette; b, Burette Stand; c, Beaker.

FIG. 28.



Urinometer.

FIG. 27.



Apparatus for Rapid Filtration (modification of Bunsen's).

Reagents and Solutions.

Distilled water Absolute alcohol Sol. carb. of soda Hydrochloric acid Nitric acid Acetic acid Sulphuric ether	To be used as indicated.
Sol. sulphate of copper Liquor potassæ	For Tromner's test.
Sol. sulphate of copper (page 175) Sol. tartrate of potassæ " Sol. caustic soda "	For Fehling's test.
German yeast—For fermentation test.	
Sol. chloride of barium (page 183) Sol. sulphate of soda (page 183)	For analysis of sulphuric acid.
Sol. acetate of soda (page 184) Sol. nitrate of uranium (page 184) Sol. ferrocyanide of potassium (page 184)	For analysis of phosphoric acid.
Sol. chromate of potassæ (page 185) Sol. nitrate of silver (page 185)	For analysis of chloride of sodium.
Sol. nitrate of mercury (page 180) Baryta solution (page 180)	For analysis of urea.

The specimen to be examined should be taken from urine passed three or four hours after eating, and should be collected in perfectly clean bottles, holding from four to six ounces.

The conditions to be carefully noted and recorded in making urinary examinations are the following:

1st. Its general appearance and odor.

2d. Its odor and taste.

3d. The quantity passed in twenty-four hours.

4th. Its reaction.

5th. Its specific gravity.

6th. The presence or absence of albumen.

7th. The presence or absence of sugar.

8th. The quantitative analysis, by which you are to determine the quantity of various normal and abonormal elements formed in urine.

9th. *The results of microscopical examinations.*

The *qualitative* and *quantitative* examination of a specimen of urine should be made within twelve hours after it is voided.

The *microscopical* examination of the sediment is best made after the specimen has stood twelve hours in a covered conical glass.

Color.—In health the color of the urine varies from a pale straw to a brownish-yellow tint. This is due to a peculiar pigment called urohæmatine. The larger the quantity daily excreted, the paler the tint; the less the amount, the darker the color.

High colored urine, when an average amount is passed, indicates the existence of some pathological condition. The most common abnormal pigment is purpurine. It abounds in the urine of persons suffering from organic diseases of the liver, is also present in many febrile and inflammatory diseases, and in those resulting from lead poisoning. In jaundice, the bile communicates to the urine a dark olive tint. Bile pigment may be discovered by adding a few drops of ordinary nitric acid to a small quantity of urine on a glass slide; as soon as the two fluids are brought into contact, the drop of acid will be fringed with a beautiful play of colors, violet, green and red, which rapidly disappear.

Blood and pus mixed with urine communicate to it their appropriate colors.

Certain vegetable and mineral substances, when taken internally, give to the urine their peculiar tint of color.

Odor.—Healthy human urine immediately after being voided has a sweetish, aromatic odor. Many kinds of food and drink transmit to the urine their peculiar odor. The odor of the urine is abnormal in Bright's disease, jaundice, diabetes, and in certain affections of the bladder.

Taste.—Normal urine has a saltish, bitter taste. In disease the flavor varies very much. In diabetes it is sweet; in jaundice it is bitter.

Quantity Passed in Twenty-four Hours.—The amount of urine voided by a healthy person in twenty-four hours greatly varies. The mean daily discharge ranges between forty and fifty fluid ounces—it may rise as high as eighty ounces, and fall as low as twenty-five ounces, and still be within the limits of health; the variation depending in a great degree upon the quantity of fluid drank.

In order accurately to determine the quantity passed in twenty-four hours, it should be carefully measured in a graduated urine glass.

Before determining the *clinical significance* of any deviation from the usual quantity of urine passed by an individual, Dr. Roberts states that the following points should be borne in mind.

When the urine is unusually scanty, it should be ascertained before pronouncing it a morbid phenomenon, whether the patient has abstained from liquids above his habit, or whether water has been eliminated in excess by some other channel, as the skin or bowels. The urine is always *scanty* in cirrhosis of the liver; in some forms of Bright's disease through their entire course. In the early stage of acute Bright's disease it is very scanty, sometimes approaching or reaching total suppression. It is also *scanty* in any condition of the heart which directly or indirectly causes passive congestion of the renal veins, whereby the circulation through the kidneys is impeded. It becomes scanty, or is suppressed, in the collapse stage of cholera.

Any diminution of the urinary secretion which approaches suppression is of most serious import.

The flow of urine is *abundant* when the surface of the body is cool, or when large quantities of fluid have been taken. In disease it is discharged in excessive quantity in two special maladies—diabetes and the stage of atrophic degeneration of the kidneys. Temporary excess of urine occurs after hysterical

paroxysms, and certain other convulsive attacks in both males and females. An increased tension in the arterial system, as in some cases of hypertrophy of the left ventricle, is associated with increased secretion of urine.

Reaction.—The reaction of urine is most readily ascertained with litmus paper. If urine is acid, it turns blue litmus paper red—if alkaline, it restores the blue color to reddened litmus paper.

When just passed, healthy urine is usually slightly acid—the acidity depending on the united presence of the acid phosphate of soda, uric, sulphuric and lactic acids. After standing for a certain time, all urine becomes alkaline from the decomposition of the urea into the carbonate of ammonia.

In febrile and inflammatory affections, especially of the liver, heart and lungs, the urine is usually abnormally acid; while in affections of the brain and spinal cord, and in certain diseases of the genito-urinary organs, it is often strongly alkaline.

Specific Gravity.—The specific gravity of healthy urine ranges between 1012 and 1030; the average is about 1020. It is lowest soon after large quantities of fluid have been taken, and highest soon after eating.

The most convenient method for estimating the specific gravity of urine is by means of the urinometer (fig. 28), an instrument consisting of a blown glass float, a small bulb weight with mercury, and a graduated stem. By floating this instrument in the urine to be tested, and reading the number which is on a level with the surface of the liquid (as shown in fig. 28), you readily determine its specific gravity with sufficient accuracy for clinical purposes.

From the specific gravity of urine, a rough estimate may be formed of the percentage of solid constituents contained in it. The most accurate and simplest formula for this purpose is that proposed by Trapp. According to this, if the two last figures of the specific gravity be doubled, the quotient will rep-

resent the amount of solid matter per 1000. A thousand grains of urine with a specific gravity of 1020 will therefore contain 40 grains of solids. If, then, the quantity of urine voided in 24 hours be known, the daily excretion of solids can be approximately ascertained.

In disease, the average specific gravity of the urine may be increased or diminished. It is highest in *diabetes*, and lowest in *hysteria*. In inflammations, as pneumonia, pleurisy, etc., and in fevers, it often rises as high as 1035. On the other hand, when the average specific gravity is abnormally low, you may suspect some exhausting, non-inflammatory complaint as Bright's disease, in which it may fall so low as 1006. As a rule, the lower the average specific gravity of the urine in chronic Bright's disease, the more unfavorable the prognosis.

The substances whose presence or absence in the urine you will most frequently be called upon to ascertain, are *albumen* and *sugar*.

Albumen.

Various methods have been proposed for the detection of this substance in the urine; but the simplest and most reliable, is the test by *heat* and *nitric acid.*

Ordinary clear and transparent urine when boiled in a test tube may, under two different conditions, present a turbid appearance. If the urine is alkaline, the turbidity will probably be due to the precipitation of the *earthy phosphates*. The addition of a little nitric acid will dissolve this precipitate, and the urine will become clear if albumen is absent. On the other hand, if the urine is *acid* when boiled, turbidity will occur, provided albumen be present in an appreciable quantity. In this instance the turbidity is due to the coagulation of the albumen, and it will not be diminished or caused to disappear by the subsequent addition of nitric acid. The presence, however, of a small quantity of nitric acid in the mixture previous to

boiling may prevent the reaction. Upon this point Beale says: "*If a few drops of nitric acid be added to a portion of albuminous urine in a test tube, and the mixture subsequently boiled, no precipitate will be produced.*" This peculiar reaction is supposed to be due to the decomposition of the phosphates of the urine by the nitric acid, the free phosphoric acid serving to keep the albumen in solution in spite of the application of heat. (Page 131.)

Clinical Significance of Albumen in the Urine.—When albumen is found in the urine, the first and important question to decide is, whether it indicates the existence of organic disease of the kidneys. This question may be decided by the temporary or permanent duration of the albumenuria, by the quantity of the albumen present, and by the presence or absence of any other disease which might give rise to it. The pathological states in which albumen appears constantly or occasionally in the urine, have been arranged by Dr. Roberts into the following groups:

1st. Acute and chronic Bright's disease of the kidneys.

2d. Pregnancy, and the puerpural state.

3d. Febrile and inflammatory diseases (zymotic diseases, such as scarlet fever, measles, small-pox, typhoid fever, cholera, yellow fever, ague, diphtheria, etc.; inflammatory diseases, such as pneumonia, peritonitis, traumatic fever, articular rheumatism, etc.).

4th. Impediments to the circulation of the blood (emphysema, heart disease, abdominal tumors, cirrhosis of liver, etc.).

5th. An hydræmic and dissolved state of the blood, and atony of the tissues (puerpura, scurvy, pyæmia, hospital gangrene).

6th. Saturnine intoxication

In the first group the albumen in the urine depends on structural changes in the kidneys. In the other groups, structural changes in the kidneys are not necessarily indicated by the

albumenuria, but rather some abnormal conditien of the circulation, or of the circulating fluid.

Sugar in the Urine.

Sugar is a normal constituent of the body, but the most delicate direct testing fails to detect its presence in healthy urine. Whenever it is found in the urine, it is a grave pathological sign.

The methods usually employed to detect the presence of sugar in the urine, are *Trommer's*, *Fehling's*, and the *yeast* or *fermentation* test.

Trommer's Test is as follows: Pour a small quantity of urine into a test tube, then add a drop or two of a solution of sulphate of copper; to this add about half as much Liquor Potassæ as there is urine. Upon shaking, the mixture becomes of a homogeneous dark blue color.

The mixture is then to be raised to the boiling point; if sugar be present, a pale reddish-brown precipitate of the sub-oxide of copper immediately appears. If albumen be present, the above reaction will not occur; hence this fact must be ascertained in advance, and the albumen, if present, must be separated by coagulation and filtration.

Fehling's Test is preferred by many, and may be performed as follows:—Measure thirty minims of a solution of sulphate of copper (90.5 *grains to the ounce*) into a test tube or flask; add thirty minims of a solution of neutral tartrate of potash (31.4 grains to the ounce); to this add two fluid drachms of a solution of caustic soda (*sp. gr.* 1.12). Boil the mixture, and add the inspected urine drop by drop. "In ordinary diabetic urine, the first few drops will produce a brilliant reddish or yellowish opaque precipitate. If the urine be added to about the volume of the test liquid, or the mixture be again brought to the boiling point without any precipitate, you may be certain no sugar is present."*

* Flint's Chemical Examination of the Urine.

Fermentation Test.—Fill a large test tube with the suspected urine, then add a small quantity of yeast, close the mouth of the tube with the finger and insert it in a tumbler containing a considerable quantity of the same urine; remove the finger without permitting air to enter the tube, and support it in an upright position by means of a small wire triangle (as shown in fig. 25, B). Set the apparatus in a warm place for twenty-four hours. If sugar be present, it will be decomposed by fermentation into alcohol and carbonic acid, the gas rising to the top of the tube, and displacing the urine; if sugar be absent, no displacement will occur. This test is reliable, provided the yeast is good and the temperature suitable.

Clinical Significance of Sugar in the Urine.—The presence of a large quantity of sugar in the urine is the most *prominent* sign of diabetes. Traces of sugar are frequently found in the urine, resulting from diseases and injuries of certain parts of the nervous system, and from impediments to the respiration; but it is principally of importance in the diagnosis of diabetes.

LESSON XVIII.

General Directions for Quantitative Analysis.—Quantitative Analysis for Albumen, Sugar, Urea, Uric Acid, Sulphuric Acid, Phosphoric Acid, Chloride of Sodium.

In the following *volumetric* methods of analysis, it must be borne in mind that the *theoretical* proportion of the various ingredients of the standard solutions are given; hence the necessity for the employment of the *purest chemicals*, and the use of distilled water in their preparation; unless prepared by a reliable chemist, they should be tested previous to use.

It is equally important that all vessels or instruments employed for measuring the quantity of urine or test solutions should be accurately graduated; for in testing a small quantity of urine and calculating for a larger quantity, any slight error or inaccuracy will necessarily be increased in magnitude.

In measuring the two drachm and half drachm portions of urine, I would advise you to dispense with the ordinary graduate, and in its stead use the pipette (fig. 25, *a*), having upon it two marks—the lower indicating half a drachm, and the upper, two drachms. Over the upper end of the pipette is slipped a piece of rubber tubing about three inches long, which may be closed by means of the spring clip belonging to the burette.

In using it, relax the spring and suck up into the tube a sufficient quantity of urine; release the spring, and the urine sucked up of course will remain. Then carefully relax the spring and permit the urine to flow out of the tube until its upper level is opposite the proper mark. The point of the pipette is then

brought into the beaker and its contents delivered. In this way the proper amount of fluid can be delivered more rapidly and accurately than if measured in a conical graduate.

For the determination of uric acid, the apparatus required is somewhat expensive; the chief expense, however, is the balance, which should be sufficiently delicate to indicate the $\frac{1}{50}$ of a grain. When loaded with the necessary weights, it can be obtained for about twelve dollars.

The drying of the filters and precipitate should be conducted with *great care;* they should not be considered dry until two successive weighings agree, showing that all moisture has been expelled.

The apparatus usually employed for the purpose of drying, is the ordinary water-oven; this is somewhat expensive. Dr. Piffard has devised, at trifling cost, a simple addition to the water-bath which will accomplish the same purpose (shown in fig. 24, *c*, *d*). The filters employed in the uric acid analysis should be of the finest Swedish paper, the best attainable for analytical purposes. For ordinary filtration, the German paper will answer as well, and is cheaper.

To hasten the process of filtration, Dr. Piffard has devised a modification of Bunsen's method of rapid filtration. The platinum funnel point and paper are carefully arranged as directed by Bunsen,* the cork (which should be of rubber), through which passes the stem of the funnel, is inserted into the mouth of a "Thudicum's nasal douch," or other bottle of similar construction previously filled with water. From the lower opening of the bottle hangs a rubber tube furnished with a stopcock (fig. 27). On opening the cock the water flows out, rarefying the air in the bottle and inducing a rapid flow of the contents of the funnel; not only is the filtration facilitated, but the time requisite for subsequently drying the precipitate is

* Vide *Freeman's Quantitative Analysis.*

materially shortened. This piece of apparatus, although not absolutely necessary, will be found of great convenience.

As has already been stated, the *qualitative* analysis of the urine is rarely called for, except for detecting the presence of *albumen* and *sugar;* but a *quantitative* determination (from time to time during the progress of a disease) of albumen and sugar, as well as of certain normal ingredients of the urine, is often of great importance, and can be easily and rapidly accomplished by volumetric processes.

Quantitative Analysis for Albumen.—To ascertain the amount of albumen in a given quantity of urine, first weigh an ounce of urine, then add to it a small quantity of acetic acid, and bring it to the boiling point; collect the precipitate that is thrown down, on a filter carefully dried and weighed. After drying and weighing the precipitate, its proportion is readily calculated.

An approximate estimate, but one sufficiently accurate for clinical purposes, may be made, by adding acetic acid and boiling a given quantity of urine in a test tube. After allowing the precipitate to settle, its proportion to the amount of urine employed is readily appreciated.

Quantitative Analysis for Sugar.—In order to determine the number of grains present in an ounce of diabetic urine, the method proposed by Dr. William Roberts is the simplest, and is sufficiently accurate for practical purposes.

The following is his mode of procedure:

1st. Four ounces of urine are placed in a twelve-ounce vial, with a lump of German yeast of the size of a walnut.

2d. The vial is then loosely corked, or covered with a slip of glass, and placed in a warm place to ferment.

3d. A companion vial filled with the same urine, say a three-ounce vial, is tightly corked and placed beside the fermenting vial.

4th. In about twenty-two hours, when fermentation has ceased, the two vials are removed to a cooler place.

5th. Two hours after,—that is, about twenty-four hours from the commencement of the experiment,—the contents of the vials are separately poured into cylindrical glasses, and the density of each observed.

6th. The difference in specific gravity of the two is thus ascertained, and every degree of "density lost" indicates one grain of sugar per fluid ounce of the urine.

By the volumetric analysis the quantity per ounce of many of the normal ingredients of the urine may be readily ascertained. It is not necessary for me to detail to you the *rationalé* of the *volumetric method*, nor of the reactions observed; the operative procedures alone are of practical utility.

Urea.

Urea, though found in the urine, is not formed in the kidneys, but only excreted by them from the blood. It is present in the normal human blood in about .016 parts in a thousand, and a healthy adult excretes about 500 grains in twenty-four hours. The quantity, however, is subject to considerable variation, depending on food, sex, age, and climate.

Its sources are two-fold: 1st. The degeneration of tissues; 2d. The excess of nitrogenized food absorbed into the circulation.

The quickest and most accurate method of ascertaining the quantity of urea contained in a given specimen of urine is the one devised by Liebig, which is as follows:

This test requires *two solutions:* one, by dissolving 92.64 grains of red oxide of mercury in the smallest possible quantity of strong nitric acid, and diluting the product to six fluid ounces with water. The other solution is made by mixing one volume of cold saturated solution of nitrate of baryta with two volumes of a similar solution of caustic baryta.

Procedure.—Mix a convenient quantity of urine with half its volume of the baryta solution, and pour the mixture upon a

dry filter. When a sufficient quantity of clear fluid has passed, put a drachm of it into a beaker, add a little distilled water, and bring it under the burette filled to the *o* mark with the mercuric solution. Deliver the test solution into the beaker as long as a distinct precipitate is seen to form. Have in readiness a plate of black glass upon which has been placed a few separate drops of a solution of carbonate of soda. A drop of the mixture in the beaker is to be brought from time to time in contact with the soda on the glass; if the color remains white, free urea is still present; but when it becomes yellow, the addition of the mercuric solution is to be discontinued, and the number of grains of the test solution used is to be ascertained by looking at the burette.

This number divided by 20 will give the number of grains of urea per ounce of urine.

Clinical Significance.—In disease, the quantity of urea contained in the urine may be abnormally increased or strikingly diminished. It is *abnormally increased* in all febrile affections (except yellow fever), in all nervous affections (especially in epilepsy), in pyæmia, in diabetes, and as a rule, in acute inflammation of the thoracic viscera. It is *abnormally diminished* in cholera, in some cases falling as low as 60 grains in 24 hours.

In *Bright's disease*, the diminution in the quantity of urea in the urine is most marked and significant. In one case I found the daily excretion by the kidneys as low as 57 grains; as a rule, the more albumen in the urine, the less the amount of urea, and *vice versa.*

But not unfrequently, in patients with atrophied, waxy, or cirrhotic kidneys, the quantity of albumen may be slight, or for a time entirely absent (the urine being of low specific gravity), and still the quantity of urea daily excreted falls far below the normal standard; so that in all forms and stages of those kidney changes included under the term Bright's disease,

it is important to determine accurately the quantity of urea contained in each day's urine,—it is not only an important element in diagnosis, but also in prognosis.

Uric Acid.

Uric acid, like urea, can be detected in the blood in health; but whether or not it is formed in the circulation or in the tissues, is undetermined. In health it is always present in the urine. A healthy adult secrets in the urine 8.56 grains in twenty-four hours; the quantity, however, greatly varies according to the kind of food taken.

Quantitative Analysis of Uric Acid.

Experts have decided that the volumetric methods proposed for the quantitative determination of uric acid are not sufficiently accurate; hence, you will be obliged to employ the somewhat more tedious method of isolating and weighing this substance. The process proposed by Dr. J. W. T. Arnold, and given in Prof. Austin Flint's manual on "Examination of Urine," is not very complicated or difficult,—it may be described as follows: Take one fluid ounce of filtered urine and evaporate it over a water-bath to the consistency of a thick syrup; remove the urine from the water-bath, and add about half an ounce of absolute alcohol; mix the urine with the alcohol in the most thorough manner,—when sufficiently mixed, pour off the alcohol upon a *dried* filter, the weight of which has been ascertained. Extract in this way two or three times, or until the alcohol no longer takes up any coloring matter. After pouring off the alcohol into the filter, the residue left in the evaporating dish should be extracted in the same way with about an ounce of dilute hydrochloric acid (one part of acid to six of water), and the whole poured on the filter used to separate the alcoholic extract. The residue upon the filter should then be washed with a wash-bottle with the acid, and afterwards with distilled water.

After the liquid has separated, the filter is dried in a water-oven, and carefully weighed. The difference in the weight of the filter before and after the experiment will indicate the amount of uric acid present in the portion of urea experimented upon.

Sulphuric Acid.

The amount of sulphuric acid in healthy urine depends on two things: 1st, on the metamorphosis of the tissues containing sulphur and sulphates; 2d, on the food. The quantity daily excreted in the normal urine varies from 15.023 to 21.188 grains. The minimum amount is formed during fasting; the maximum after a full meal. The process for determining the quantity present in any specimen of urine, is as follows:

Put two drachms of filtered urine into a small beaker, add about half an ounce of distilled water, and a little hydrochloric acid. Place the mixture on a water-bath to warm. Then fill a 200-gr. Mohr's burette (Fig. 26, *a*) to the 0 mark with a solution of chloride of barium (6.1 grs. to the ounce). When the urine in the beaker (Fig. 26, *c*), has become hot, bring it under the burette, and permit a small portion of the baric solution to drop into it. A precipitate will immediately form; then add a fresh portion of the test solution, and continue the process until no more precipitate forms. The quantity of the test solution employed is ascertained by looking at the burette and reading off from its scale the number of grains delivered. This number divided by 60 will give the number of grains of sulphuric acid in each ounce of urine under examination.

In order to be certain that no more of the baric solution was added than was necessary to effect the precipitation of all the sulphuric acid, let the beaker stand until the precipitate entirely settles. Pour off a portion of the clear fluid, and add a few drops of a solution of sulphate of soda. If much precipitate occurs, it is evidence that too much of the test fluid has been employed, and the analysis must be repeated.

The Clinical Significance of an excess or diminution of sulphuric acid in urine is still a matter of doubt. It has been found to increase in delirium-tremens and in febrile and inflammatory diseases, and to diminish in chlorosis and affections of the spinal cord.

Phosphoric Acid.

Phosphoric acid seems to play a very important part in the animal economy. It is found in the blood, urine, nerves, and muscles. A healthy adult daily excretes with the urine about 50 grains.

The quantity contained in a given ounce of urine is determined as follows: As before, put two fluid drachms of filtered urine in a beaker, add thirty minims of an acid solution of the acetate of soda (made by *adding* 66.6 *grains of acetate of soda and double the quantity of acetic acid to an ounce of distilled water*), and to this add a convenient quantity of distilled water, say half an ounce, and place the mixture in a water-bath. Fill the burette with a solution of nitrate of uranium (14.19 *grains to the ounce*). When the urine in the beaker becomes hot, bring it under the burette and deliver into it the uranium solution; a precipitate of the phosphate of uranium will form and continue to be produced by the addition of fresh portions of the test fluid until all the phosphoric acid has been appropriated. During the process, if a drop of the urine in the beaker be removed and placed on a white saucer, and a drop of a dilute solution of ferrocyanide of potassium be brought in contact with it, no immediate change will occur until the phosphoric acid of the urine has been wholly appropriated by the uranium, and an excess of the latter is present in the mixture, in which case a brownish-red precipitate immediately forms at the line of junction of the two drops. The point in the process at which this occurs must be watched for with great care, and indicates the termination of the analysis.

The number of grains of the uranium solution employed to effect this result divided by 60, will give the number of grains of phosphoric acid contained in an ounce of the urine.

Clinical Significance.—Like most urinary ingredients, the amount of phosphoric acid eliminated in the urine undergoes a marked change in disease. It has been found to be abnormally increased in all inflammatory diseases of the nervous system, in paralysis, or any severe nerve lesion, in acute mania, delirium-tremens, and in rickets. It is diminished in most febrile and inflammatory affections, especially pneumonia (unless nerves or nerve centers are involved), in Bright's disease, in gout, and in rheumatism.

Chloride of Sodium is found in every animal fluid and solid, and seems to be quite indispensable to the development and growth of the body.

In health, the quantity eliminated in the urine in twenty-four hours is about 75.5 grains. The presence or absence of the chlorides from the urine is readily ascertained by adding a few drops of a solution of nitrate of silver to the urine; the immediate formation of a white precipitate indicates the presence of chlorides.

The Quantitative Analysis is effected as follows: Take, as before, two drachms of urine in a beaker (if the urine be previously filtered through animal charcoal containing no trace of chlorine, the terminative analysis will be greatly facilitated), render it neutral or *faintly* alkaline by the addition of the carbonate of soda, or nitric acid, as may be necessary, and add two or three drops of a saturated solution of chromate of potash, together with half an ounce of distilled water. Bring it under the burette filled to the *o* mark with a solution of nitrate of silver (5.8 grains to the ounce). The addition of the silver solution to the contents of the beaker will be immediately followed by the appearance of a red precipitate (chromate of silver); upon stirring, the red color will disappear, the chromate of

silver disappearing, and the chloride of silver taking its place.

The addition of a fresh portion of the test fluid will be followed by the reaction so long as there remains in the beaker any chlorine not combined with the silver. When, however, the whole of the chloride of sodium has been decomposed, the addition of a fresh portion of the test fluid will be followed by a permanent red precipitate, and indicates the termination of the analysis. The number of grains of the test fluid necessary to produce this result divided by 60, will give the number of grains of chloride of sodium in an ounce of the urine under examination.

Clinical Significance of Chloride of Sodium.

An increase of the chlorides in the urine in disease is rarely if ever met with, and has no clinical significance; but their diminution or absence is of so frequent occurrence in certain forms of disease as to become an important aid in their diagnosis. Their absence is most marked and constant in the exudative stage of acute inflammation, especially in pneumonia during the stage of hepatization, when they may be absent for two or three days, but return as soon as resolution commences. They are often absent in fevers, especially in typhus. In acute rheumatism, as soon as the endocardium and pericardium become implicated they generally suddenly disappear. Chloride of sodium is absent or diminished in cholera, and its increase or return is regarded a very favorable symptom.

The following list of prices for apparatus already referred to, has been furnished by George Tieman & Co., of this city.

12 Test Tubes and Stand	$2 00
Conical Glass	50
" " Graduated	75
Glass Spirit Lamp	75
Piece Black Glass, 3 x 3	10
Funnel	50

Measuring Pipette (Piffard's)	$ 40
Evaporating Dish, 4 inch	50
2 Brushes for cleaning Tubes, 15 cts	30
3 2-oz. Beakers	50
Water Bath	2 60
Water Oven (Piffard's)	1 50
Retort Stand	1 50
Bunson Burner	2 00
Swedish and German Filtering Paper	75
Piffard's Filtering Apparatus, $3	3 00
Litmus Paper, 20 cts	20
Urinometer	1 00
Balance (made by Becker & Sons, carrying 1000 gr. in each pan and turn $\frac{1}{10}$ gr.)	10 00
Weight, Becker's, warranted accurate, 10 gr.—$\frac{1}{50}$ gr.	1 50

LESSON XIX.

Microscopical Examination of the Urine.

In order to avail yourselves of the assistance of the microscope in the diagnosis of urinary and renal diseases, it is necessary that you should be familiar with the appearances presented by no less than *five classes* of minute bodies met with in urine sediments. These are

1st. *Certain crystals.*

2d. *Casts.*

3d. *Mucus, pus, blood, spermatozoa.*

4th. *Fungi* or *minute vegetable organisms.*

5th. *Extraneous matter* which is accidentally present.

Crystals.

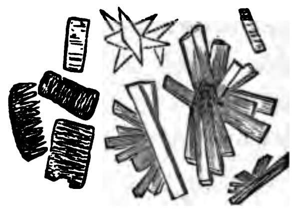
Normal urine never contains sediment. The appearance of crystals within twelve or even twenty-four hours after the urine has been passed, is a sure indication of an unhealthy condition of the system; it may be temporary, but nevertheless it is abnormal. The crystals most frequently met with are those of uric acid, ammonia, magnesium (called also triple phosphates), oxalate of lime, and an amorphous deposit of the urates.

Uric Acid.

Uric acid assumes a multitude of forms; each form, however, is well defined and generally very easily recognized. Figs. 29 and 30 show the forms most frequently met with.

When a crystal assumes an unusual form, so that you are in doubt regarding it, add a drop of caustic potash; after the crystal has become dissolved, neutralize the solution with a little

Fig. 29.



Lozenge-shaped and Rhomboidal Crystals of Uric Acid.

Fig. 30.

Aggregated or flat Stellated Crystals of Uric Acid.

hydrochloric acid, and generally the uric acid will recrystallize in one of the more common forms.

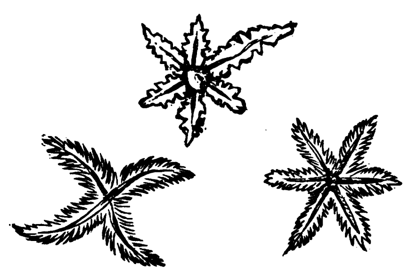
The color also is a great aid to their diagnosis, for no crystals so readily take up the coloring matter of the urine as those of uric acid. They are usually of a yellowish red color.

These crystals are frequently deposited around tube casts and epithelium. The clinical import of uric acid has already been referred to.

Triple Phosphates.

The ammonio-magnesium phosphates or triple phosphates are generally beautiful microscopic objects, but their appear-

Fig. 31.



Crystals of Triple Phosphates rapidly deposited.—HARLEY.

ance varies with the rapidity of their crystallization. When they crystallize rapidly, as occurs when ammonia is added to freshly passed urine, they assume a feathery form, singly or in stellate groups, as shown in fig. 31.

When they are allowed to crystallize slowly, the urine becoming gradually alkaline from the decomposition of the urea, they assume the forms of well-defined prismatic crystals, as shown in fig. 32.

Fig. 32.

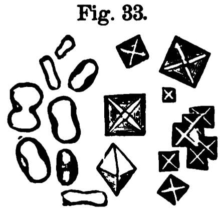
Triple Phosphates slowly deposited.

The pathological indication of the phosphates has been considered in the quantitative analysis of phosphoric acid.

Oxalate of Lime.

This salt usually occurs as a minute colorless octohedra, more rarely in the form of dumb-bells, shown in fig. 33.

Fig. 33.



Octohedra and Dumb-bell shaped Crystals of Oxalate of Lime.

As these crystals are exceedingly minute objects, it will be necessary to use a high power.

The only *two* sediments which you will be liable to confound with the oxalate of lime, are the triple phosphates and uric acid. The prisms of the triple phosphates sometimes appear octohedral in shape, and the diamond crystals of uric acid are occasionally so small as to be mistaken for oxalates; the doubt, however, is easily dispelled, for acetic acid will dissolve the phosphates, and caustic potash will cause uric acid to disappear, while oxalate of lime resists the action of either of these agents.

Clinical Significance.—Oxalic acid is not known to be a normal constituent of the body; the presence of oxalate of lime in the urine, therefore, indicates an abnormal condition of the

system, now generally conceded to be a chronic poisoning of the brain and spinal cord, by minute quantities of oxalic acid in the circulation. The name *oxaluria* has been given to a class of cases in which for months the urine contains a deposit of oxalate of lime.

This deposit is accompanied by a well-marked train of symptoms mostly of a nervous and dyspeptic character, which if disregarded, soon carry the patient into a state of confirmed hypochondriasis.

Urates.

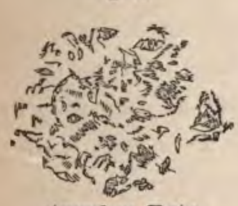
The urates are usually deposited in a fine granular or amorphous condition, but occasionally the urate of ammonia occurs in spherical bodies of a brownish color, with or without fine projecting spicula, as shown in fig. 34.

Fig. 34.

Urate of Ammonia.—BENNETT.

By warming the urine the amorphous urates are dissolved. In normal urine the urates are in a state of solution, but whenever they chance to be in excess, or the water of the urine is diminished, they are deposited in an amorphous state. Fig. 35.

Fig. 35.



Amorphous Urates.

Fig. 36.

Urate of Soda.

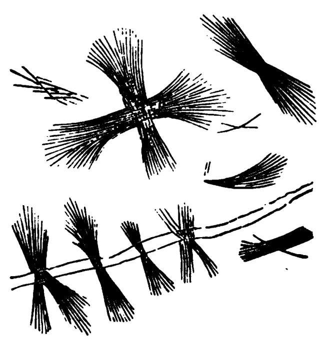
Liebig has shown that the most common form is the urate of soda (fig. 36), distinguished from the others by its great solubility. The *clinical significance* of the urates depends upon

the circumstances under which they appear. They may be deposited after slight indigestion, after great mental or physical exertion; a sudden change in the mode of life is a common cause. They often appear suddenly in the urine in acute febrile and inflammatory diseases. If the deposit is persistent without any apparent cause, it deserves immediate attention, as it is not unfrequently the forerunner or associate of urinary calculi.

Xanthine, *hypoxanthine*, *guanine*, *leucine*, *creatine*, and *creatinine*, are found in the tissues and blood in small quantities; occasionally they appear in the urine. Dr. Roberts states that they may be regarded as intermediate steps in the retrogressive metamorphosis of azotized tissues, of which the ultimate stages are urea, uric acid, carbonic acid and water. Any retardation of this metamorphosis at a certain stage occasions their appearance in the urine.

Clinical Significance has not as yet been determined with sufficient clearness for practical purposes. Tyrosine, xanthine, and leucine, are the only ones that form spontaneously in the urine. These substances have been found in the urine in typhoid fever and acute yellow atrophy of the liver. Roberts gives the representation of tyrosine (shown in fig. 37) as occurring in the urine of a patient with acute yellow atrophy of the liver.

Fig. 37.



Tyrosine.

Cystine.

Cystine is a crystalline body of great rarity; it is not dissolved by heat or by vegetable acids, but by caustic am-

monia. It is spontaneously deposited in the urine in the form of flat hexagonal plates (shown in fig. 38).

Fig. 38.

Cystine.

Clinical Significance.—It has no positive clinical import; its deposit seems to depend upon a peculiar diathesis,—"runs in families,"—and is usually connected with the formation of calculi.

Casts.

These bodies are little cylindrical or tubular masses of coagulated matter which, formed in the renal tubules in consequence of disease, are washed down by the fluid secreted behind them, and appear mingled with it after its exit from the bladder.

They are of different sizes corresponding to the calibre of the tubes in which they are formed, and present different aspects, according to the nature or stage of the disease which produces them. They are usually divided into *exudative, or fibrinous, desquamative or epithelial, fatty, granular, hyaline or waxy.*

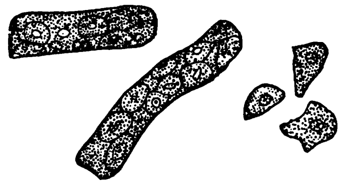
Exudative or fibrinous casts consist of masses of coagulated matter which has been poured into the uriniferous tubes and then solidified, and subsequently washed down into the bladder; they appear with or without adhering epithelial cells from the tubules (shown in fig. 39). These casts are most frequently met with in the first stage of the inflammatory form of Bright's disease.

Fig. 39.

Exudative Casts.

Desquamative or epithelial casts are portions of the lining membrane of the tubules detached in coherent pieces. The cells are often opaque, presenting the

Fig. 40.



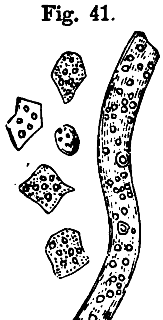
Epithelial Casts.

character of unhealthy epithelium. (Fig. 40.)

Fatty Casts.—If the epithelium of the tubes has undergone fatty degeneration, you will find these casts studded with minute globules of oil, constituting the so-called *fatty casts.* (Fig. 41.)

Granular Casts.—In some cases the cells thus degenerated are so numerous that the whole mass appears composed of fatty matter,—in other cases they are mingled with more or less hyaline material. If the oil be in a state of extremely minute subdivisions, it presents a granular aspect, constituting the granular casts. (Fig. 42.)

Fig. 41.



Fatty Casts and Epithelium.

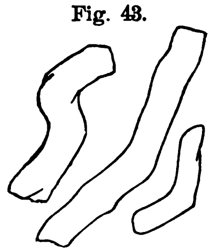
These casts are most frequently met with in the second and third stages of the inflammatory form of Bright's disease, especially indicating the large white or granular kidney.

Fig. 42.

Granular Casts.

Hyaline or waxy casts present an extremely transparent appearance, containing neither fat, epithelium nor granules, but only the outlines by which they are recognized. (Fig. 43.)

Fig. 43.



Hyaline Casts.

Their formation depends upon the exudation of fibrine through the degenerated walls of the vessels, and its coagulation within the uriniferous tubules. They are often absent for two or three days at a time; then, sometimes for the next two or three days they will be present.

These casts may be met with in the

atrophied stage of all forms of Bright's disease. They do not (as at one time was supposed), indicate waxy kidney. Associated with all varieties of casts, you may find blood disks and crystals, either resting upon or imbedded in their substance. In the former instance, the association may be accidental, and may have taken place in the bladder or in the vessels which received its contents; in the latter it is evident that they have been derived from some portion of the renal track.

Epithelial Cells.—In addition you may find *epithelial cells* from the uriniferous tubes, either singly or in groups of two or three or more. In fact, any part of the genito-urinary passages may shed its epithelium so as to form a sediment in the urine. The different varieties usually met with are shown in fig. 44.

Fig. 44.

A, Vaginal Epithelium; B, Normal Renal Epithelium; C, Atrophied Renal Epithelium; D, Epithelium from the Bladder: E, Epithelium from Pelvis of Kidneys.

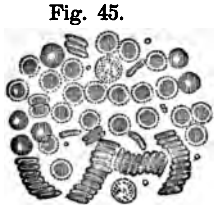
Whenever renal epithelium and blood corpuscles appear in the urine in connection with any variety of tubular casts, you have reason to infer that acute inflammation or intense congestion of the kidneys exists.

Blood in Urine.—Blood, when mixed with urine (if considerable in quantity), imparts to it a reddish or smoky appear-

ance. If it has its origin in the kidneys, it will be diffused equally through the urine; if in the urethra or bladder, distinct clots are sometimes visible.

The microscopical appearances of blood corpuscles are so well known and easily ascertained that a description is hardly necessary. The marks by which they are distinguished from other cells found in the urine, are the absence of visible cell contents—of nuclei—and their feeble refractive power. (Fig. 45.)

Fig. 45.



Red Blood Globules.

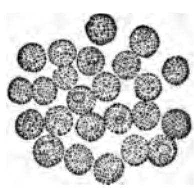
The clinical significance of blood in the urine depends entirely upon its origin. It may arise from local lesions in the kidneys and bladder—such as *injuries*, *calculi*, *pyelitis*, *cystitis*, *active hyperæmia*, *nephritis*, etc., or from *constitutional* causes, as *purpura*, *scarlet fever*, *cholera*, etc.

Pus in the Urine.—Pus gives to the urine, when voided, a milky appearance; after standing, a yellowish white sediment is deposited, which, if the urine is alkaline, after a time becomes viscid and tenacious.

If the urine voided is acid, you have reason to believe that the pus has its origin in the kidneys; if it is alkaline, that it has its origin in the bladder.

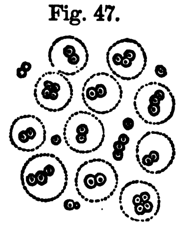
The microscopical appearances of pus are as familiar to you, and as easily ascertained, as are blood corpuscles, and consequently do not require description. (Figs. 46 and 47.)

Fig. 46.



Pus Corpuscles.

Fig. 47.



Pus Corpuscles after the addition of Acetic Acid.—BENNETT.

You can distinguish them from other cells in the urine,—by

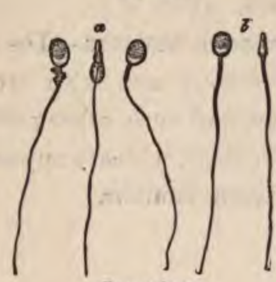
their large size, by their granular appearance, and from the action of acetic acid upon them, rendering their nuclei distinct (fig. 46), and if it is added in excess, the entire disappearance of the cell wall and the contents of the cell.

The significance of pus in the urine depends upon its source.

Suppuration may take place in any part of the genito-urinary passages, or abscesses may rupture into them at any point. It is often difficult and sometimes impossible to decide upon their point of origin.

Spermatozoa in the Urine.—Semen in the urine gives rise to a deposit, in appearance like mucous, which, placed under the microscope, reveals the existence of spermatozoa. As seen in the urine, they are always motionless, consisting of a minute, oval head, with a tail-like extremity. The length of the entire filament is $\frac{1}{700}$ of an inch (shown in fig. 48).

Fig. 48.



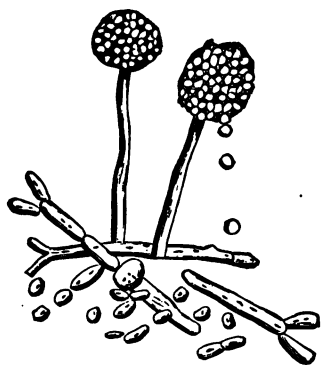
Spermatozoa.

Spermatozoa are met with in the urine after *sexual intercourse*, *involuntary nocturnal emissions*, and occasionally after *defecation* and *micturition*. Their clinical significance is determined by the attending constitutional symptoms. In the majority of cases their presence in the urine is unimportant.

Vegetable Fungi.—The minute vegetable organisms most frequently met with in the urine are—

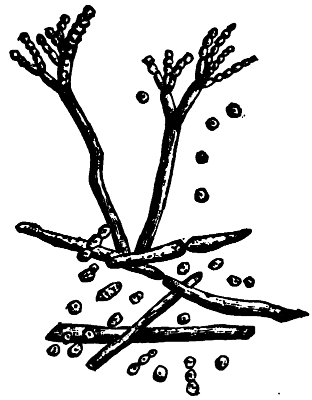
Torula Cervisiæ, found in diabetic urine. (Fig. 49.)

Fig. 49.



Torula Cervisiæ.—ROBERTS.

Fig. 50.



Penicilium Glaucum.—ROBERTS.

Penicilium Glaucum, found in acid albuminous urine. (Fig. 50.)

Fig. 51.

Sarcinæ.—ROBERTS.

Sarcinæ, found under circumstances not well understood. (Fig. 51.)

Extraneous Matters.—The extraneous matters most frequently met with are cotton, linen, or wool fibre, and such other particles as are usually found in dust and sweepings, with the appearance of which you can easily make yourselves familiar.

MECHANICAL AIDS TO DIAGNOSIS.

LESSON XX.

Mechanical Aids in the Diagnosis of the Diseases of the Respiratory and Vascular Organs.—Stethoscope.—Stethometer. — Cyrtometer. — Cardiometer. — Laryngoscope. — Sphygmograph.

I WILL now briefly describe the different instruments which may be employed as aids in physical diagnosis, and give some rules to guide you in their use.

Stethoscope.—In the diagnosis of diseases of the respiratory and vascular organs, a *stethoscope* is not only often convenient, but at times absolutely essential. A great variety of stethoscopes have been devised, each inventor claiming for his own instrument some superiority in principle or shape. They may all be referred to two general classes, viz., flexible and solid. I regard as the best representative of these two classes those devised by the late Dr. Camman, of this city. For general use, I would recommend his Binaural stethoscope, which has fitted into the cap that is applied to the surface two flexible tubes; these are connected with two metal tubes curved so that they fit into each ear, which are connected with each other by means of a metal bar with a toggle-joint in its center, so that the tubes can easily be adjusted to the ears, and an elastic band holds them in position, as is shown in fig. 52.

It requires some practice to become adepts in its use; but once accustomed to it, you will, I think, find no other stethoscope superior to it, for it closes both ears to all but the desired sounds.

Fig. 52.

Camman's Stethoscope.

In selecting a stethoscope, you should be careful that the ear pieces exactly fit your ears; if they are too large they will cause pain, and if too small they will produce a roaring sound which will obscure the sounds you desire to examine.

In cardiac auscultation, and in determining abnormalities of the blood-vessels, this instrument will be found almost indispensable,—for pulmonary auscultation it is only occasionally of service.

Chest Measures.—The simplest way to determine the distance between two fixed points, or to ascertain the circular measurement of the chest or abdomen, is by means of a graduated tape; but not unfrequently the *amount* of motion and the *exact shape* of the chest or abdomen are far more important than their size. The best instrument for determining the amount of motion of the chest or abdomen, as well as the difference in the motion of the two sides, is *Quain's stethometer.*

Fig. 53.

Quain's Stethometer.

Stethometer.

This instrument is composed of a brass box with a dial, and an index which is moved by a rack attached to a silken cord; one revolution of the index indicates an inch of motion, the intervening space being graduated, as shown in fig. 53.

It may be employed when the patient is in a standing, sitting, or recumbent posture. *The mode of its application* is as follows: Place the box on the sternum

with the index pointing to the median line; carry the silken cord around the chest to the spines of the vertebræ, where it should be held firmly with the thumb or finger.

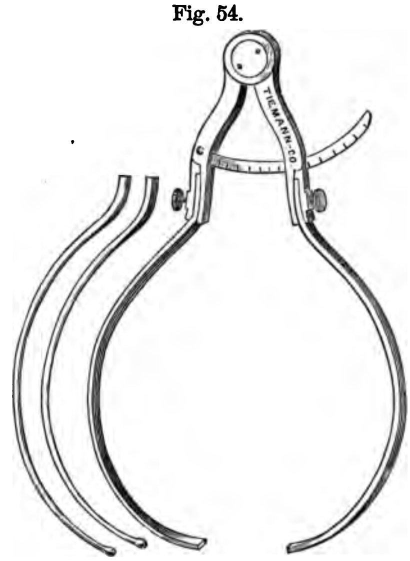
The amount of motion of the side under examination at the end of an expiration and a full inspiration, will be accurately shown by the index.

This instrument is of great utility in determining the exact amount of difference in the expansion of the two sides of the chest, as well as for determining the amount of local expansion in any region.

Cyrtometer.

This instrument for obtaining accurately the *shape* of the chest, was made in 1860 by G. Tiemann & Co. (instrument makers), from suggestions given them by Prof. Austin Flint. It resembles in principle the cyrtometer of Woiller, invented in 1857.*

Fig. 54.



Cyrtometer.

It consists of an ordinary compass with short arms; slits are made in the ends of these arms to receive narrow strips of lead, which are made long enough to encircle the chest and meet in the median line in front; they are fastened into the arms of the compass by means of thumb-screws. An indicator is attached to the center of one arm, and slides through a slit in the other; this is arrested at any point by means of a thumb-screw (shown in fig. 54).

* *Vide* Gazette des Hôpitaux, 1875, p. 184.

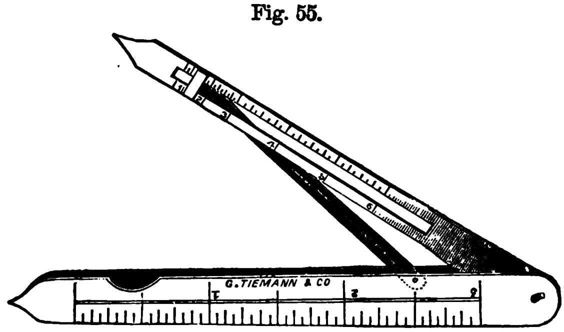
When applied, the arms of the compass are pressed on each side of the vertebral column and fastened by means of the thumb-screw pressing on the indicator; the strips of lead are easily moulded so as to fit any depression or elevation of the chest; the thumb-screw is then loosened and the instrument removed. After its removal, bring the arms of the compass together until they reach the same notch in the indicator as when the instrument was applied to the chest; fasten it with the thumb-screw, place it upon paper, and you can easily trace the exact shape of the chest.

Cardiometer.

The cardiometer was devised by the late Dr. Camman of this city, to determine accurately the distance of the apex beat from the median line.

In shape, it resembles a pocket-knife with one extremity rounded and the other slightly pointed; on its handle is a scale of inches which may be used as an ordinary rule. Enclosed in the handle is a metal bar which extends the whole length of the handle, and is attached by a pivot to its rounded extremity; this bar is pointed at its free extremity, and has a slit through

Fig. 55.



Camman's Cardiometer.

its center. A second smaller bar is attached by a pivot to one side of the handle near its rounded extremity; the other end

of this bar is made to slide along the slit in the large bar, and has a small indicator attached to it.

The larger is so marked off by a scale, that, as it is opened from the handle, the indicator sliding along the slit indicates the number of inches between its pointed extremity and the corresponding extremity of the handle (shown in fig. 55).

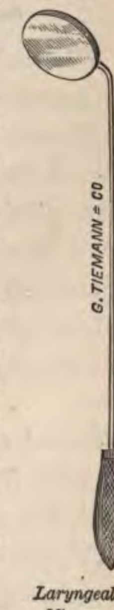
In using this instrument, place the pointed extremity of the handle on the median line and open the larger bar to a point corresponding to the apex beat; by reading the figure marked by the indicator, you determine the number of inches the apex beat is distant from the median line.

In recording cases, and in determining accurately slight changes in the position of the apex beat, this instrument will be found of service.

The Laryngoscope.

This instrument, constructed for examining the interior of the larynx, consists of two parts: *First*, a small mirror fixed to a long slender shank which is introduced into the pharynx and held in such a position that it will reflect an image of the larynx and adjacent parts; *second*, an apparatus for throwing a strong light (solar or artificial) on the small mirror. For this purpose a second large mirror, which reflects the light from a lamp or the solar rays upon the throat mirror, is used.

Fig. 56.



Laryngeal Mirror.

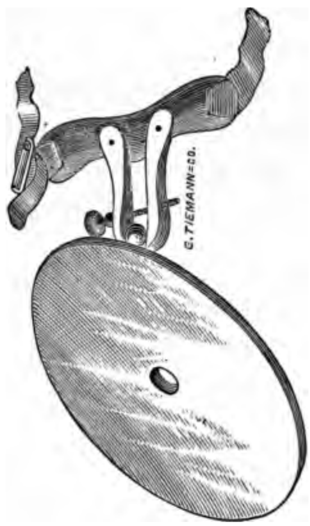
The throat or *laryngeal mirror* should be of glass, at least one inch in diameter, backed with a coating of silver, mounted in German silver, and fixed at an angle of about 120° to a slender shank about four inches in length of the same material; the other extremity of the shank should be fixed into a wooden handle. The best form is the one devised by Prof. Türch, and represented in fig. 56.

In order to be able easily to examine all cases, it

is well to be provided with four mirrors, ranging from $\frac{5}{8}$ inch to $1\frac{1}{8}$ inches in diameter.

The large mirror, represented in fig. 57, should be attached to the forehead by a band passing around the head, or to a spectacle frame after the method of Dr. Mackenzie. A lamp (any one that gives a bright, steady light answers the purpose perfectly well) should be placed on a table at the side of the patient, the flame being on a level with the patient's eyes. A lens may be employed to increase the intensity of the light.

Fig. 57.



Head Mirror.

Method of Examination.—Seat yourself directly in front of your patient about one foot from him, with his head slightly inclined backward.

First.—Endeavor to throw a disk of light from the reflector on your forehead upon his fauces, so that the center of the disk shall correspond with the base of his uvula. When you have gained dexterity in throwing the disk of light, direct him to open widely his mouth and put out his tongue, which you must grasp between the thumb and finger of the left hand, previously enveloped in a napkin. In thus keeping the tongue out, the greatest gentleness should be used, as the employment of force, by exciting reflex action, only defeats the object in view.

Second.—Take the throat-mirror, previously warmed over the lamp (to prevent the condensation of the breath on the surface), like a pen in your right hand, and introduce it to the back part of the throat, its face directed downward and kept as far as possible from the tongue. Let the posterior sur-

face of the mirror rest slightly on the base of the uvula, which should be pushed upward and backward towards the posterior nares. The plane of the mirror should form an angle of about 45° with the horizon.

It is better to introduce the mirror several times, and keep it "*in situ*" only a few seconds, than to allow it to remain too long, and thereby produce an irritation which prevents farther examination at the sitting.

The administration of a few grains of bromide of potassium a few hours previous to the examination, will be found of service in rendering the parts less irritable.

Laryngoscopical View of the Larynx in a Normal Condition.—In the laryngeal mirror, when it has been introduced into the pharynx, as already directed, the *first* thing that comes into view is the back of the tongue with its large follicles, *then* the hollow space between it and the anterior or glossal surface of the epiglottis, which is of a dark pink color.

Next, the apex and laryngeal surface of the epiglottis, the free surface being of a yellow color, while the laryngeal or under surface is invariably of a bright-red color.

Next, the *ary-epiglottic folds*, which are of about the same color as the mucous membranes of the gums.

Next, the *ventricular bands*, having about the same color as the mucous lining of the lips.

Next, the *vocal cords*, which are pearly white, like the sclerotic.

Next, the *tracheal rings*, which are of a decidedly yellow color, the mucous membrane between them being of a bright red.

Lastly, the bifurcation of the trachea and the bronchi.

In making your laryngeal observations, as soon as the posterior wall of the larynx is brought into view, note carefully the *form*, *size*, *color*, *position*, and *mobility* of the *true* and *false vocal cords*, as well as all their relations and form of motion,

and the appearance of the anterior wall of the larynx from the free border of the epiglottis down to the trachea.

For the purpose of investigating the action of the vocal cords, the patient should be directed to inspire deeply or to produce a vocal sound, as *ah*, *eh*, etc.

You must remember that the objects seen in the laryngeal mirror are reversed as regards their antero-posterior direction. This reversed picture is somewhat troublesome to the beginner, as everything has changed position. By frequently examining in succession these different parts in the order already given, you will soon become familiar with their normal appearance and motions, and so be prepared to recognize abnormalities, and thus be enabled to reach a positive diagnosis as regards the character, seat, and extent of any laryngeal affection.

The laryngeal diseases, in which the laryngoscope is of special service as an aid in diagnosis, are *thickening*, *induration*, and *ulcerations* of the vocal cords, *paralysis* of the vocal cords, *polypi* or *malignant growths* springing from any portion of the larynx, *exudation* on the mucous surface of the epiglottis or larynx, *follicular enlargements* and *ulcerations*, as well as other changes which may occur in the course of chronic laryngitis or trachitis.

Rhinoscopy.

Instead of directing the laryngeal mirror *downwards*, if it be curved behind the uvula and directed *upwards*, a posterior view of the pillars of the fauces and the nares may be seen, with the openings of the Eustachian canals.

The laryngoscope then becomes a *rhinoscope*. In examining the posterior nares in this way, it may be necessary to draw the uvula forwards by a small blunt hook or curved spatula. After the introduction of the mirror, you can steady it by resting your third and fourth fingers on the patient's lower jaw. In this way you will be able to see the roof of the pharynx,

the septum nasi, the posterior orifices of the nasal fossæ, the middle and lower turbinated bones, and the orifices of the Eustachian tubes.

As in the case of the larynx, *morbid alterations*, *polypi*, *ulceration* of the hard and soft parts at the back of the nose, *thickening* of the mucous membranes, etc., can be seen, and readily distinguished from a healthy state of the parts. In cases of deafness dependent on obstruction of the nasal passages, it will also enable you to make an exact diagnosis.

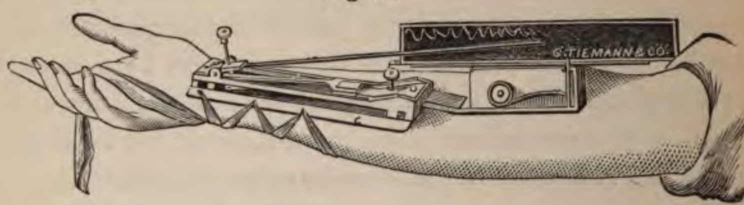
The Sphygmograph.

Various modifications of the sphygmograph have been devised by different experimenters; but the one which seems to me to be the best, is that which was invented by M. Marey, of Paris, to determine various points in the physiology of the circulation of the blood.

This instrument consists of a brass frame with a wing fastened to each side by hinges, so as to spread out upon the arm when the instrument is applied; enclosed in this frame is a flexible steel spring, covered on the under surface of its free extremity with an ivory plate, which rests upon the artery or vein to be examined, and is connected by means of a bar of metal, which has a vertical plate attached to it, with a very light lever moving upon a pivot; the vertical plate is brought in contact with the lever by means of a screw. Attached to the free extremity of the lever is a small pen, which when filled with ink, marks its movements upon the paper which covers the brass plate; this plate is moved at a uniform rate by means of watchwork placed in the small box beneath. Ten seconds are occupied by the passage of the plate. A thumb-screw winds up the watchwork, and a small lever starts the plate or stops it, as desired. Silk bands embrace the arm and hook on to projecting points on each wing, as seen in fig. 58.

The sphygmograph has recently been employed as an aid in the diagnosis of diseases of the *heart*, *arteries*, and *veins*. When

Fig. 58.



Marey's Sphygmograph.

properly adjusted, it is claimed that it gives an exact representation of the *pulse wave*, the *frequency* and *regularity* of the *pulsations*, and enables one to see at a glance *any peculiarity in an arterial pulsation*.

Considerable care must be used in adjusting the instrument; if the radial artery is to be examined, the instrument should be firmly applied to the arm, with the ivory pad resting on the artery just beyond the lower extremity of the radius; if too much pressure is exerted upon the pad, it will compress the walls of the artery so as to prevent your obtaining an exact representation of the pulse. *Each representation* of a pulse wave is composed of three parts,—the line of *ascent*, the *summit*, and the line of *descent*.

The line of ascent is produced during the flow of blood into the arterial system, and is nearly synchronous with the heart's systole.

The summit of the pulse wave designates the period during which the entrance balances the onward flow.

The line of descent by its obliquity marks the celerity of the fall of pressure within the vessels, and the facility with which the blood passes on in its course,—it is nearly synchronous with the heart's diastole. You will sometimes notice one or more undulations or secondary waves in this line, which may be

perceptible to the finger. The first of these waves has been termed the *false*, and the second the *true dicrotism.*

The frequency of the pulse may also be studied by means of this instrument. As the plate moves at a uniform rate, the number of pulse waves made during its passage indicates the number of cardiac pulsations in ten seconds.

The force of the pulse is indicated by the height of the pulsation.

In a normal radial pulse trace, the line of ascent is vertical, the summit a mathematical point, the line of descent oblique, and the second secondary wave or true dicrotism well marked, as shown in fig. 59.

Fig 59.

Normal Radial Pulse. (After Dr. B. W. Foster.)

In aortic obstruction the peculiarity of the trace consists in an obliquity or break in the line of ascent, marking the gradual flow of the blood into the vessels. (Fig. 60.)

Fig. 60.

Aortic Obstruction. (Dr. Foster.)

In aortic regurgitation the great peculiarity of the trace consists in the suddenness of the line of descent. (Fig. 61.)

Fig. 61.

Aortic Regurgitation. (Dr. Foster.)

In mitral obstruction the pulse, although usually regular,

is of such low tension that it is easily depressed and altered in form by the pressure of the instrument. (Fig. 62.)

Fig. 62.

Mitral Obstruction. (From a patient in Bellevue Hospital.)

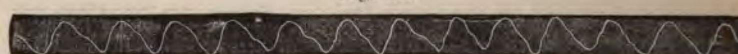
In mitral regurgitation the pulsations are frequent, and there is great depth and amplitude of the diastolic notch. (Fig. 63.)

Fig. 63.

Mitral Regurgitation. (From a patient in Bellevue Hospital.)

Mitral and aortic regurgitation combined gives a trace with an oblique line of ascent, a rounded summit, and an oblique line of descent, with a very small dicrotism. (Fig. 64.)

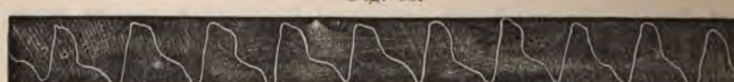
Fig. 64.



Mitral and Aortic Regurgitation. (From a patient in Bellevue Hospital.)

Aortic obstruction and regurgitation combined, shows a vertical line of ascent, a summit composed of a horizontal line of considerable length, and a marked dicrotism. (Fig. 65.)

Fig. 65.



Aortic Obstruction and Regurgitation. (From a patient in Bellevue Hospital.)

Mitral and aortic obstruction and regurgitation combined, show a vertical line of ascent of great height, a sudden fall in the line of descent, with a very prominent false dicrotism, while the true dicrotism is but slightly marked. (Fig. 66.)

Fig. 66.

Mitral and Aortic Obstruction and Regurgitation. (*From a patient in Bellevue Hospital.*)

Senile change in the vessels and consequent loss of elasticity is indicated by the high position and great size of the first secondary wave as compared with the true dicrotism. (Fig. 67.)

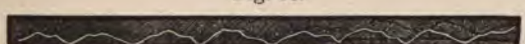
Fig. 67.

Senile Pulse Trace. (*Dr. Foster.*)

Hypertrophy of the Left Ventricle.—The pulse tracings closely resemble those of old age.

In aneurisms of the ascending aorta the pulse of the right radial artery is much smaller than that of the left, as may be seen by comparing the two tracings in fig. 68.

Fig. 68.



Right Arm.

Left Arm.

Aneurism of Ascending Aorta. (*From a patient in Bellevue Hospital.*)

Clinical Significance—The *exact* clinical importance of the arterial tracings obtained by the sphygmograph is not as yet fully determined. Dr. Sanderson considers it "*likely*" that this instrument is to be of great use in determining the probable duration of life, as there are persons in whom, in the absence of any other trace of ailment, the pulse curve indicates

that the arterial resistance is excessive. Drs. Anstee and Foster are of the opinion that the diseases in which the sphygmograph will prove of most value are: First, in aortic regurgitation, by estimating the extent of the valvular imperfection; second, in discovering unsuspected commencing cardiac hypertrophy, senile disease of the arteries, and in capillary disease depending on degenerative processes in the ultimate tissues; third, in discovering the existence of intrathoracic aneurisms and in deciding the locality of an aneurism.

Dr. Anstee has made a series of observations in fever, pericarditis, pneumonia, and delirium-tremens, which shows that in this direction the sphygmograph promises to be of great value in indicating the amount of arterial tension. There seems to me little doubt but that the amount of arterial tension may be accurately determined by the sphygmograph, and I am convinced that the instrument is a better index of the condition of the arteries than of the heart.

LESSON XXI.

Mechanical Aids in the Diagnosis of Diseases of the Nervous System, and in General Diseases.—Ophthalmoscope.—Thermometer.—Microscope.—Dinamometer.—Æsthometer.—Exploring Trochar.—Specula.

Ophthalmoscope.—The simplest and least expensive ophthalmoscope is Liebreich's.* It consists of a concave circular mirror about seventeen inches in diameter, and from ten to twelve inches focal distance, perforated in the center by a small circular aperture. Behind the mirror is a hinged clip, into which eye-pieces may be adapted, three of which are concave and two are convex, from six to twelve inches focal distance. On the side of the mirror is a shank which fits into a handle about six inches in length, by which the mirror can be held in any position desired. In addition to these there is a convex object lens of two and one-half inches focus (shown in fig. 69).

Fig. 69.

Liebrich's Ophthalmoscope.

* The best instrument for the direct method of examination is that of Dr. Loring, of this city. The refraction of the eye examined may be determined by its use, it having a complete series of convex and concave glasses, which, by an ingenious revolving disc arrangement in the mirror, may be placed before the eye of the observer. The student who desires to give much attention to ophthalmoscopy will probably prefer this instrument, although it is more expensive than that of Liebrich's.

The examination is best made in a darkened room, the examiner and patient sitting or standing face to face.

There are two methods of examining the eye with this instrument, the *direct* and *indirect.* In both a lamp is placed at the side and a little behind the patient's head, the flame being on a level with his eyes. The handle of the mirror is held between the thumb and forefinger, and the eye-piece at the aperture of the mirror is brought close to one of your own eyes in such a manner that the light from the lamp is reflected into the eye under observation. If you desire to make a *direct* examination, bring your eye which is armed with the mirror very close to the patient's eye, at the same time adjusting your eye for objects at an infinite distance, that is to say, having the accommodation at rest. The examiner should use the corresponding eye in examination with the one being examined. If the eye of the observer and that of the patient be of normal length, a clear image will be obtained; if not, the proper correcting glass, convex or concave, may be used. The patient should turn his eye a little outward and across the room upon some object.

In *indirect* examinations, the lamp and mirror are arranged the same as for the direct, but the mirror is only brought sufficiently near the eye to be examined to bring the focus of the reflection upon the optic disc; having done this, take the convex lens between the thumb and first finger of the hand not engaged with the mirror; rest the second and third fingers of this hand on the patient's forehead so as to steady the lens, and move it to and fro directly in front of the eye under examination until you find the focus,—your little finger remains free to raise the lid, if necessary, or to press upon the eyeball.

When by practice you have acquired dexterity in manipulating this instrument, and by repeated examinations of the normal eye have become familiar with the appearance of the normal retina, optic disc, and choroid, you will be able readily to recognize many of the pathological changes in those structures

which are now becoming important elements in the diagnosis of diseases of the brain, spinal cord, and other vital organs.

The importance of this instrument in the diagnosis of diseases of the eye is universally admitted, so that no ophthalmic surgeon of the present day regards the examination of an eye complete without an ophthalmoscopic examination. I shall not attempt to detail its diagnostic uses in this branch of surgery, but will briefly state its uses in medical diagnosis, as it is coming to be regarded of no little importance.

An ophthalmoscopic examination of an eye may show the *optic disc* to be the seat of *simple hyperæmia*, *anæmia*, *ischyæmia*, or congestion and effusion, within and around it; of *inflammation* of its sheath, or of its substance; and lastly, of atrophy.

It may show the *retina* to be the seat of *hyperæmia*, *anæmia*, of *fatty exudation patches*, or of *hemorrhages*.

It may show the *choroid* to have partially or altogether *lost its pigment* and to be the seat of *hemorrhages*, to have undergone *atrophy*, etc.

It may show the *blood-vessels* within the eye *diminished*, *obstructed*, *dilated*, *tortuous*, *varicose*, *pulsating*, or to be the *seat* of *embolism*, *thrombosis*, or *rupture*.

Hyperæmia of the Disc may occur in the vessels of the disc, in the retinal veins, or in both retina and papillæ together. The larger vessels and chiefly the retinal veins are seen dilated, darker in color than natural, slightly tortuous, or even varicose.

To pronounce upon *slight* hyperæmia of the disc or retina is a delicate and difficult task; generally the hyperæmia is to be first seen on the inner half of the disc. In states of hyperæmia, when pressure is made on the ball of the eye, pulsations in the veins are more marked than in the normal condition. Direct examination is important in these cases.

Clinical Significance of Hyperæmia of the Disc or Retina.— Its causes are many. *First*, it is frequent in the first stage

of ischæmia, of neuritis, or of an atrophic process. It may be due to orbital disease, to choroiditis, to Bright's disease, to alcoholismus, to cerebral tumors, to acute or chronic meningitis, and to active cerebral hyperæmia; transient hyperæmia may be seen in forms of cardiac disease which obstruct the venous circulation, and in Grave's disease.

Anæmia of the Disc and Retina is the opposite of hyperæmia. It is always accompanied by anæmia of the retina and choroid. It is liable to be mistaken for atrophy of the disc; but the edges of the disc are not so sharp and well defined as in atrophy, and it is possible to distinguish the arteries from the veins; again, anæmia is equal in both eyes, atrophy is not; besides atrophy rarely involves a whole disc equally as does anæmia.

Clinical Significance.—The causes of anæmia of the disc or retina are the same as those of general or local anæmia.

Ischæmia of the Disc is a mechanical venous congestion, œdema, and punctate extravasation of the disc; the disc is swollen, rising abruptly on one side and sinking gradually on the other; its color varies from a bright transparent gray to a dirty red; the margin of the disc is wholly concealed by infiltration and excessive vascularity, which gives it a mossy appearance; the veins of the retina are tortuous,—they may be *very* tortuous.

It is difficult and sometimes impossible to distinguish this condition from optic neuritis; the two are frequently associated.

Clinical Significance.—The causes of ischæmia of the disc are all those changes within the skull which more or less directly distend the ophthalmic veins. The three main causes are, *chronic meningitis*, *hydrocephalus*, and *tumors.*

The lesions of the *optic disc* which seem to have the closest connection with cerebral, spinal, and general diseases, are *hyperæmia* and *anæmia of disc and retina*, *optic neuritis* with its consecutive atrophy, and primary or progressive atrophy.

In *optic neuritis*, the disc becomes larger than usual, its edges indistinct, irregular and puffy, the infiltration casting a veil over it, so as to change its color into a lilac grey, and more or less to conceal the vessels as they pass within its margin. The veins increase in size, become tortuous, or even varicose; they darken in color and seem to be gorged with blood. The capillaries, which in their normal state ought not to be seen, also become evident, and give a mossy or woolly appearance to the disc. (Graefe.)

Clinical Significance.—Optic neuritis is very generally co-existent with *meningitis* at the base of the brain, *with cerebral tumors* and *large cerebral hemorrhages.*

It can only be distinguished from the *retino-neuritis* of albumenuria, and from the *retino-choroiditis* of syphilis,—by the history of the case, by its limitation for the most part to the papillæ and the conveying vessels. Its resemblance to ischæmia has already been stated.

In the *consecutive atrophy* of optic neuritis, the intense vascularity in and about the disc subsides, the infiltrations are absorbed, the nerve whitens, and the capillaries slowly shrivel and vanish. The edges of the disc become distinct but are deformed, and patches of organized lymph are to be seen upon and about them.

In *progressive atrophy* of the optic disc, the fine capillaries which give the rose tint to the healthy disc slowly disappear, and a dead or pearly white is left. The border of the disc is sharp, clearly defined, flat and even.

This lesion generally depends upon some disease of the cerebrum-cerebellum, or spinal cord.

The most *important* indications of organic disease capable of being recognized by an ophthalmoscopic examination of the eye, have been summed up by Dr. T. C. Allbutt as follows:

In the *first stage of meningitis* there is dilatation of the veins

of the retina, peripapillary congestion, and often external effusion. In the second stage the veins become tortuous, thrombotic, and sometimes ruptured.

In basilar meningitis, optic neuritis is present, but not in meningitis of the convexity.

Intercranial affections which directly distend the ophthalmic veins, as hydrocephalus and intracranial tumors, cause ischæmia of the discs, and if the pressure is extreme, atrophy of the optic nerves.

Acute and *chronic cerebral softening* causes acute or chronic optic neuritis and atrophy. Cerebral hemorrhage, when large, by its obstruction causes stasis in the vessels and effusion in and about the optic disc.

In diseases of the spinal cord, as progressive atrophy, sclerosis and chronic myelitis, simple progressive atrophy of the optic disc is not uncommon.

In Bright's disease the nutrition of the optic nerve, as well as that of the retina, is interfered with; upon the retina, extravasations are seen in the course of the vessels; these extravasations are slowly effused and pass into degenerative states, forming white patches or striations along the margin of the veins; most of these patches have evidently been clots; some may be due to the degeneration of retina.

In syphilis, the choroid is the chief seat of lesion, and patches of many colors are to be seen at the back of the eye; some of brilliant white and others of darker tints, as red or brown. We also have intense neuro-retinitis in syphilis, but its appearances cannot positively be distinguished from those of any other forms of neuro-retinitis.

Thermometer.

The *thermometer* is now regarded an indispensable mechanical aid in the diagnosis of disease.

I prefer (and would recommend to you), the *straight, self-registering clinical thermometer*, represented in fig. 70.*

This thermometer consists of a glass stem six inches in length, having on it a graduated scale varying from 85° to 115° Fahr., exhibiting .5° Fahr. The upper extremity of the stem is closed; at the lower end there is a bulb of mercury as thick as the diameter of the stem. Within the stem is a bit of mercury detached from the column of mercury in the bulb called the index; this index is set by taking the bulb and stem of the instrument firmly in the hand, when by repeated sudden blows of the wrist upon the knee, the index is brought down the stem to a point just below the lines which indicate the degrees. After the index has thus been set, the bulb of the instrument may be applied to the *axilla, between the thighs, in the mouth, rectum, or vagina*, or to any *part* where it can be *completely covered*.† Before introducing the bulb it is well to hold it in the closed hand until the mercury shows a temperature of 98°. Neglect of this precaution is apt to lead to an under statement of temperature. When the instrument has been in perfect contact with the parts for five or seven minutes, gently remove it, and the top of the index will denote the maximum temperature of the part. The patient should be in bed one hour before the temperature is taken.

Fig. 70.

Straight Self-Registering Thermometer.

If the *axillary temperature* is to be taken, the axilla

* Tiemann & Co. will furnish this instrument *absolutely accurate*, each instrument having been carefully tested.

† Dr. E. Seguin, of this city, has devised a thermometer for determining localized surface temperatures. The peculiarity of this instrument is, that the mercurial bulb is flattened, so as to furnish a large surface at its base. Dr. Seguin claims for this instrument *facility* and *accuracy* in determining the surface temperature of different parts of the body.

should first be thoroughly dried, and the bulb of the instrument placed directly beneath the fold of the pectoralis major muscle, the forearm on that side being carried across the chest, and the elbow held by the other hand of the patient, or by an assistant.

If the *rectal or vaginal temperature* is to be taken, the parts should first be thoroughly cleansed with warm water, and the patient placed on the side.

The *mouth* is the least reliable place at which the temperature can be taken, for the temperature in this cavity is constantly varying according to the quantity and temperature of the respired air.

Thermometrical observations, if possible, should be continuous, and be taken at least twice in the twenty-four hours,—from 7 to 9 A. M., and from 4 to 7 P. M.

In cases of doubtful diagnosis, and in very active disease, they also should be taken at noon and at midnight.

The *pulse* and *number of respirations* should be noted at the time the temperature is taken. The *rate of rise* in the temperature indicates the degree of heat, and should be noted.

Range of Temperature in Health.

The normal temperature taken in any of the above-named localities, varies from 97.5° F. to 98.4° F. Any rising above 99.5° F., or depression below 97.3° F., *if persistent*, is a *sure index of disease.* Temporary risings or depressions of one degree may be produced by diet, stimulus, exercise, etc.

Ranges of Temperature in Disease.

The greatest range of temperature in disease is 17.0° F., the minimum being about 95° F., and the maximum, 112.55° F. (The highest recorded temperature was made by Wunderlich.) The highest temperature ordinarily met with in severe and fatal cases, rarely exceeds 107° F.

A single thermometrical observation is an important element

in differential diagnosis *when taken in connection with other symptoms*, but it has no independent diagnostic value.

Axillary temperature below 100° F., excludes the existence of fevers,—above 101° F., leads to the probability of fever,—when it exceeds 108° F., you may probably exclude fever.

A temperature at 107° F. indicates malignancy, and when met with for two consecutive days in typhus, scarlatina, measles, pneumonia, pyæmia, meningitis, or rheumatic affections, death is almost certain to follow. In relapsing and in pernicious intermittent, the temperature may rise to 107° without indicating great danger.

In many diseases, during the last few hours of life, the temperature suddenly rises as high as 109° F., or even 111° F.; especially is this true in tetanus, sunstroke, typhus, pyæmia, etc. A temperature below 98° does not necessarily indicate collapse, but is more likely to be met with in the aged and feeble when subjects of grave disease.

Thus it is evident that a given temperature without its antecedents is apt to mislead in diagnosis. When isolated, the highest temperature only portends danger, and with a temperature at 95° F., collapse is not certain.

Daily Variation of Temperature in Disease.

Daily thermometrical variations in disease depend upon the *elements which constitute the morbid processes, the intensity of these processes*, and the *stage* they *have reached;* also somewhat on the *idiosyncrasy* of *the patient.*

A single day's variations may determine the severity and stage of a disease; but you must compare the variations of a number of days, before (in a large proportion of cases) you can reach a diagnosis.

High average temperature, above 104° F., is met with in remittent, typhus, typhoid, and relapsing fevers, in severe pneumonia, etc.

A moderately high average temperature above 102° F. is met with in catarrhs, cerebro-spinal meningitis, diphtheria, dysentery, pleurisy, pericarditis, acute rheumatism, peritonitis, etc.

A slight average rise in temperature above 100° F. has a varied significance, and is met with in a large class of chronic affections, and at the commencement of acute inflammations, and mild types of fever.

When your thermometrical observations follow regular diurnal variations, with a rise each day of one degree,—as, first day—morning, 99.5° F.; evening, 101.5° F.; second day—morning, 100.5° F.; evening, 103.5° F.; third day—morning, 101.5° F.; evening, 104.5° F.,—you have almost certain evidence of typhoid fever; if the temperature does not exceed on any evening 103.5° F., the fever will probably have a mild course; if it reaches 105° F. in the evening, it shows that the attack is a severe one, and forebodes danger. A sudden and marked reduction of temperature to 95° F., during the third week of typhoid fever, denotes hemorrhage from the sloughs of Peyer's patches.

If a patient with *measles* retain a high temperature after the eruption has faded, it indicates some complication.

Whatever differences of opinion may exist in regard to the importance and reliability of thermometrical observations as elements of diagnosis, the following propositions, it seems to me, may be regarded as established:

1st. An abnormal temperature determines the presence of some disturbance in the animal economy.

2d. Certain degrees of temperature indicate fever.

3d. The height of the temperature decides the severity and danger of a disease.

4th. Thermometrical observations aid us in discovering the laws which regulate the course of certain diseases.

5th. When the normal thermometrical course of a disease has been determined, its diagnosis is simplified.

6th. The *thermometer* indicates quickly and certainly any deviation in the regular course of many diseases, the transition from one stage to another, and the commencement of convalescence.

7th. It reveals the occurrence of complications.

8th. It often reveals the imminence of a fatal termination.

9th. It sometimes shows the impossibility of the continuance of life.

10th. It is an important guide as regards the effects of remedial agents.

Microscope.

In considering the microscope as an aid to diagnosis, it is not necessary to discuss the optical principles on which microscopes are constructed, or to describe in detail their mechanical construction.

Of the various models which have been invented, the one here figured (fig. 71), called *Queen's Clinical Microscope*,* is, I think, the best for the price of any now in market.

Fig. 71.

Queen's Clinical Microscope.

It consists of a base and arm of iron finished in a light-green bronze, whilst the body and all other parts are of highly finished brass. The height of the entire instrument is fourteen inches. At the point where the compound body is attached to the base, there is a hinge-joint which allows the instrument to be used at any desired angle. The *coarse* adjustment is situated at the point where the barrel is joined to the arm,

* James W. Queen & Co., 525 Broadway, N. Y., has made arrangements to have these instruments constantly on hand. Price $80.

and works on an entirely new principle; the fine adjustment is accomplished by a micrometer screw situated just above the nose, where the objectives are screwed on.

The stage is movable and of glass, beneath which a tube is fitted for carrying the diaphragm and accessory illuminating apparatus.

The mirror is fitted with a ball and socket joint, and has a plane and concave surface. Two eye-pieces, a bull's-eye condenser, needles, forceps, and a case in which the articles named, together with the stand, can be packed, complete the instrument.

The magnifying power ranges from 50 to 600 diameters.

If a still higher power is desired, I would recommend you to procure an "immersion lens" of $\frac{1}{10}$ inch (this microscope is arranged with a Society Screw, so that any objective can be fitted to it), which is of sufficient magnifying power for almost any tissue element, and can be used with very little trouble; it is only necessary to place a drop of distilled water on the first lens by means of a camel's-hair pencil, then by the coarse adjustment bring down the objective until the water touches the glass cover with which the object to be examined should be protected, and carefully bring the preparation in the desired focus.

After the lens has been used, always carefully wipe it with a soft, clean piece of linen.

Methods of Examination.

Objects may be examined by *transmitted* and by *reflected* light. By the former we ascertain the composition and structure of an object; by the latter we only determine the peculiarities of its surface.

For examination by transmitted light an object must be sufficiently thin and transparent to permit light to pass through it, while thickness and opacity present no impediment to an examination of its surface by reflected light.

In examining any substance or tissue by transmitted light you proceed as follows: Place in the center of a glass slide, which has been carefully cleaned, a drop of the fluid to be examined (as pus, blood, serum, mucous, sputum, etc.). If the fluid is thick, a drop of distilled water is then added, and the whole covered with a square of thin glass. If the object to be examined is a solid, a thin section made with a "Valentine's knife," or better, a thin-bladed razor, is placed in the center of the glass slide,—a drop of distilled water, serum, glycerine, or other solution is then added, and the whole covered with a thin glass cover as before. If necessary, the section may be teazed out or unraveled with sharp-pointed needles before covering it with the glass cover.

Many structures may be examined best in water, but generally tissues should be examined in a medium which closely resembles that which surrounds them before they are removed from the body: thus albumen and water is a very useful fluid in which to examine many structures.

For rules as to the best mode of hardening, staining and preserving specimens, I refer you to Beale's "How to Work with the Microscope," or "Frey on the Microscope."

Clinical Microscopy.

A complete application of the microscope for purposes of diagnosis requires you to be familiar with the microscopical appearance of all the normal constituents of the body; such knowledge few are able to attain. I shall therefore only call attention to those examinations which may be made at the bedside, and with which it is possible for every practising physician to become familiar.

Blood.—By a microscopical examination of the blood you can determine the relative number of the red and white globules. If the red globules are greatly diminished in number,

you have anæmia; while a marked increase in the number of white globules determines the existence of lucocythæmia.

Pigment in the white globules or in the form of free granules is met with in malarial fever and in malarial cachexia, and its presence often becomes of essential service in differential diagnosis of fever, being present in malarial and absent in typhoid and typhus.

A shrivelling and disorganization of the red globules is sometimes met with in extreme cholæmia and other diseases marked by extensive blood changes.

Recently cryptograms, spores and peculiar cells have been found in the blood in various diseases, and are by some observers believed to be important elements in the diagnosis of certain contagious diseases. Nothing as yet has been fully settled in this direction.

Urine.—The importance of a microscopical examination of the urine as an element in diagnosis has already been considered in Lesson XVIII.

Sputum.—A microscopical examination of the sputum often settles questionable points in the diagnosis of bronchial and pulmonary diseases; for the products which are developed in the bronchial tubes and air cells during the inflammations and other morbid processes which occur in these tissues, as well as substances retained in the pulmonary tissue from the respired air, appear in the sputum. In all doubtful cases of chest disease, the sputum should be subjected to a careful microscopical examination.

To *examine sputum*, two or three small pieces of the sputum should be removed with forceps from the mass, and placed at different points on the same glass slide, so that they may be separately examined; if the specimens are tenacious and opaque, they should be teazed or broken up with needles so that the various elements or particles may be readily separated from each other. If it is necessary to add a fluid, glycerine and

water is the best. Each specimen should be covered with a thin cover in the usual manner.

If you are in doubt as to the stage of a phthisical process, the presence of small fragments of pulmonary tissue in the sputum (which can only be determined by a microscopical examination), affords positive evidence that the stage of softening and excavation has commenced.

The presence of pneumonic exudation in the sputu of capillary bronchitis, indicates the existence of a lobular pneumonia, which perhaps could not have been recognized by physical examination.

Vomited Matters.—The results of microscopical examination of matters vomited are often of service in diagnosis, especially when such examination reveals the presence of various morbid products, such as blood, pus, cancer cells, vegetable fungi (as the various kinds of torulæ, especially the sarcina ventriculi), fatty epithelium, tubular casts, coloring matter, etc.

In examining vomited matters, it is well to examine that portion of the vomit which is ejected after the stomach is emptied of all articles of food and drink.

It is necessary to examine several specimens taken from different parts, in order to ascertain the general microscopical character of the whole mass; these portions may be removed on the point of a knife, or if the vomit be very fluid, by a pipette, and placed on the slide.

Substances Passed by the Bowels.—Under some circumstances a microscopical examination of the fæces has an important diagnostic value; as, for instance, when these discharges contain pus, blood, membranous exudation, confervoid growths, torulæ, mucous mixed with the debris of epithelial cells, etc.

The presence of any one of these elements in the fæcal discharges, taken in connection with the attending symptoms, often enables one to reach a positive diagnosis which could not be reached without such examinations.

Uterine and Vaginal Discharges.—A microscopical examination of these discharges has recently come to be regarded by gynæcologists as important in the differential diagnosis of uterine disease.

In subjecting them to examination, it is better to avoid the addition of water or other fluid if possible.

The following substances may be met with in these discharges: *pus*, *blood*, *epithelium*, *cancer cells*, *membranous masses*, *granular cells from cervix uteri*. Dr. Tyler Smith has an interesting article on the microscopical character of leucorrhœal discharges in his work on Leucorrhœa.

Dropsical and other fluids contained in cavities after they have been removed by the exploring trochar, may be subjected to a microscopical examination, from the results of which you may be able not only to determine the character of the contents of cysts or cavities examined, but by knowing their microscropical elements you are able to determine the character of the morbid process which is producing them.

Morbid Growths.—By subjecting minute portions of morbid growths to a microscopical examination, you are often able to make a positive diagnosis as regards their character and stage of development.

In this way the microscope becomes of essential service in the differential diagnosis of all *tumors* whose situation is such as to permit of the removal of small portions of their substance.

Cutaneous Eruptions.—A microscopical examination of the products developed in and upon the skin, is often important to the differential diagnosis of cutaneous diseases.

In cutaneous morbid products may be found animal and vegetable parasites,—aggregated epidermic scales mingled with the debris of vegetable confervæ, pus globules mingled with granular matter, fatty epithelium, epithelial cells in various stages of development and various pigments. Considerable

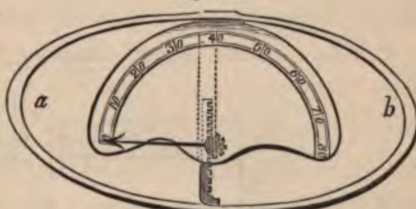
skill and experience is, however, necessary before these examinations can become of practical utility.

The Dynamometer.

The best *dynamometer* is that of M. Mathieu, an instrument-maker of Paris. It is very simple, and for measuring the strength of the hands leaves nothing to be desired.

It consists (as shown in fig. 72), of an elliptical steel spring, to which is attached a semicircle of gilt brass, upon which a scale is marked. An indicator, terminating at one end in a cog-wheel, is capable of being moved freely around the arc of the circle by a steel arm, upon one side of which, cogs, fitting into those of the indicator, are cut. One end of this arm (the lower) touches the elliptical spring, when the indicator points to the zero of the scale; a brass sheath upon the under side of the scale keeps this arm in place, at the same time allowing it to move freely.

Fig. 72.



The Dynamometer.

When the dynamometer is taken into the hand and pressed, the two sides of the spring are approximated, and the steel arm, with the cogs being pushed by the lower side of the spring, turns the indicator. One great advantage of this instrument is, that when the pressure is taken off, the indicator does not return to zero, but remains at the point to which it has been carried by the muscular power of the individual.

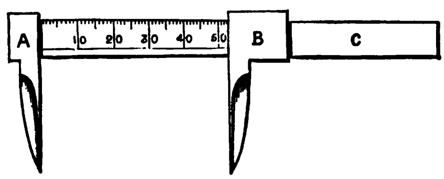
Clinically, you are able to measure accurately the strength of paralyzed muscles of the upper extremities, to determine the slightest difference in the muscular power of the two hands, as well as determine any changes that may occur from time to time in the course of coxa of paralysis.

Æsthesiometer.

This instrument was invented by Dr. Sieveking in 1858, for the purpose of accurately determining the degree of tactile sensibility of any part of the body.

It consists of a bar of metal four or five inches in length, graduated into inches and tenths of an inch. At one end is a fixed steel point; another steel point is made to slide upon the bar and can be fixed at any distance from the first by a screw which works at the top of the slide (shown in fig. 73).

Fig. 73.



Dr. Sieveking's Æsthesiometer.

It will be found that in a perfectly healthy person, when two impressions are simultaneously made upon the skin, the power of distinguishing them varies greatly in different parts of the body.

It is important that you should make yourselves familiar with the normal distance limits. You will find that at the ends of the fingers the two points can be distinguished at about one-half an inch apart, while in the middle of the back only one point can be felt, though the points are two inches apart.

In using the instrument, first fix the two points at the distance which is normal for the part of the skin to be inquired into,—the points must be applied simultaneously. If the patient feels only one point when both points touch the skin, the two points must be gradually separated from each other, and

reapplied to the part until both points are felt,—in this way you will determine the amount of *anæsthesia* present. If, on the other hand, the two points are each distinctly felt at the normal distance limit, they must be brought gradually towards each other, until only one point is felt,—thus you determine the amount of *hyperæsthesia* present.

The patient ought not to see the instrument, or know for what purpose it is applied.

This instrument aids you in determining the amount and extent of sensational impairment in cases of paralysis, as well as for determining if the loss of sensation is progressive. In the record of cases it is also of great convenience.

The Exploring Trochar.

This instrument is an aid to positive diagnosis, as it enables you to determine the character of fluid contained in a distended pleural, pericardial, or abdominal cavity, or of that contained in any fluctuating tumor or deep-seated abscess.

There are three instruments which may be used as exploring trochars, viz.: the ordinary *Hypodermic Syringe*, *Dieulafoy's Aspirator*, and *Dieulafoy's Exhausting Syringe.*

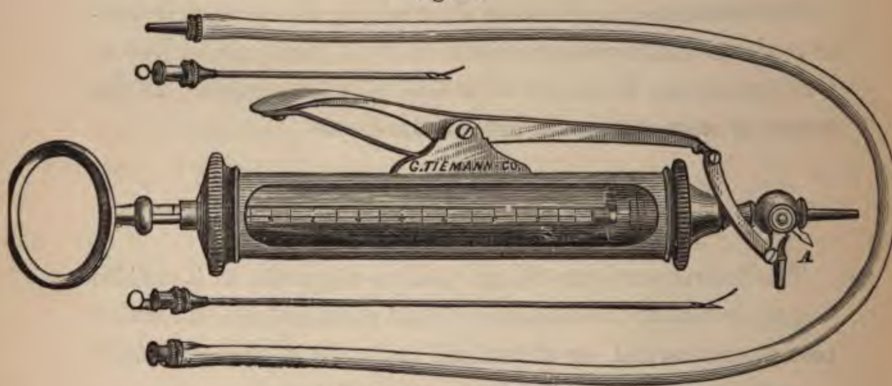
The objection to the hypodermic syringe is, that the needles are so small, and the exhausting power of the syringe so slight, that you are not always able to draw the fluid through them.

The *Aspirator* is the best instrument for the purpose, but its price places it beyond the reach of many.

The *Exhausting Syringe* is much larger than the hypodermic syringe; it consists of a glass cylinder encased in a metal mounting, which is fenestrated so that the fluid can be seen as it is drawn into the syringe; there are two branches upon which the needles may be fitted; at their junction a valve is so placed and connected by means of small bars and joints, with a handle running along the side of the cylinder, that when the

handle is depressed, the valve rotates, closing over one of the branches, so that, when the piston is withdrawn, it allows the fluid to flow through the other; when pressure is taken off, a spring returns the handle to its former position, and this rotates the valve back again, closing the branch previously opened, thus preventing the entrance of air into the needle (shown in fig. 74).

Fig. 74.



Dieulafoy's Exploring Trochar.

Two needles accompany the instrument—a large and smaller one; the former to be used when pus is suspected, the latter when you expect to find serum.

The needles are first introduced into the part to be examined, and then connected with the syringe, either directly or by means of a small rubber tube.

Dr. Dieulafoy, of Paris, the inventor of this instrument, says that it is always possible to introduce the needle without danger, in searching for fluid, no matter where it is situated, or what its nature; and that he has never met with an accident in using it.

If, after obtaining the fluid, any doubt remains as to its character, a few drops can be placed on a slide and examined under the microscope, and a positive diagnosis arrived at. The

diagnostic value of such an instrument is so readily appreciated that it is not necessary to enter into the details of its application.

Specula.

Various specula have been devised for exploring the ear, the vagina, the rectum and urethra, and in the hands of those accustomed to their use, are of material aid in arriving at a more positive diagnosis than could be otherwise obtained.

The *endescope*, an instrument constructed for the purpose of exploring and making applications to the urethra, bladder, and rectum, has a series of dark-lined metallic tubes, which are employed as *specula*, and may be used with solar or artificial light. The uses of this instrument are almost exclusively confined to the domain of surgery; I shall not, therefore, include it in the list of mechanical aids to medical diagnosis.

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Hamiltons Mixture

℞ Strychniae sulph gr viij
Cinconidiae sulph ʒ i
℥ Ferri Chlor ʒ vi
Syp Zingiberis
Acid Phosphoric dil āā ℥ xvj

Sig ʒ i T.I.D.

Pulv S.I.C.

℞ Sodii Bicarb 600 parts
Ipecac 1 "
Cubebs 3 " "

gr

Pulv P.B.S.

℞ Pepsin
Bismuth Subnit
Sodii Bicarb āā 100 pa

Dose 20 gr.

Emulsion of c. l. oil + Iq. e.

℞ Emulsion of c. l. oil (75 per cent) ℥
Dialyzed iron ʒ

Sig Table spoonful